(26,685)

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1918.

No. 599 .

MINERALS SEPARATION, LIMITED; MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, AND MINERALS SEPARATION NORTH AMERICAN CORPORATION, PETITIONERS,

vs.

BUTTE AND SUPERIOR MINING COMPANY, DESIGNATED AS BUTTE AND SUPERIOR COPPER COMPANY, LIMITED.

ON PETITION FOR WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE NINTH CIRCUIT.

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a United States Circuit Court of Appeals for the Ninth Circuit.

No. 3081.

BUTTE AND SUPERIOR MINING COMPANY, Designated as Butte and Superior Copper Company, Limited, a Corporation, Appellant,

vs.

MINERALS SEPARATION, LIMITED, a Corporation; MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, a Corporation, and Minerals Separation North American, a Corporation, Appellees.

Substituted Pursuant to Order Filed March 19, 1918, for Incorrect Copy Filed November 10, 1917.

TRANSCRIPT OF RECORD.

Volume 1.

(Pages i to cxxx.)

Upon Appeal from the United States District Court for the District of Montana.

Filed Mar. 19, 1918. F. D. Monckton, Clerk.

i (*Names and Addresses of*) *Attorneys of Record.*

Mr. Henry D. Williams, New York, N. Y.;
Mr. Lindley M. Garrison, New York, N. Y.;
Mr. William Houston Kenyon, New York, N. Y.;
Mr. Odell W. McConnell, Helena, Montana,
Solicitors and of Counsel for Complainants and Appellees.

Mr. Thomas F. Sheridan, Chicago, Illinois;
Mr. J. Edgar Bull, New York, N. Y.;
Mr. J. Bruce Kremer, Butte, Montana;
Mr. L. P. Sanders, Butte, Montana;
Mr. Alf. C. Kremer, Butte, Montana,
Solicitors and of Counsel for Defendant and Appellant.

In the District Court of the United States for the District of Montana.

MINERALS SEPARATION, LIMITED; MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Be it remembered, That on the 10th day of October, 1913, a Bill of Complaint was filed herein, which said bill is in the words and figures as follows, to-wit:

ii United States District Court, District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, Plaintiff,

vs.

BUTTE & SUPERIOR COPPER COMPANY, LIMITED, Defendant.

Bill of Complaint.

The plaintiff for its Bill of Complaint alleges:

1. That the plaintiff is a corporation duly organized and existing under and by virtue of the Laws of Great Britain and an inhabitant of Great Britain, and having its principal office in London, England; and that, on information and belief, the defendant is a corporation duly organized and existing under the Laws of the State of Arizona and has a regular and established place of business in the City of Butte, Silver Bow County, State of Montana, where it has commit-ed acts of infringement hereinafter complained of.

2. That this suit is brought under the patent laws of the
iii United States for the infringement of United States Letters Patent No. 835,120, issued November 6, 1906, for improvements in Ore Concentration.

3. That on the 29th day of May, 1905, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, being within the meaning of the statutes of the United States then in force the original, first and joint inventors of a certain new and useful process of ore concentration, and being entitled to a patent thereon under the provisions of said statutes, duly filed in the United States Patent Office an application for Letters Patent for the said invention, and that on the 6th day of November, 1906, all of the requirements of the statutes then in force having been duly complied with, the said Letters Patent of the United States No. 835,120 were duly issued on said application to the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, which Letters Patent, or a duly certified copy thereof, the plaintiff will produce as this Court may direct.

4. That on or about the 7th day of December, 1909, the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot duly assigned to the plaintiff all rights, title and interest in and to the said invention and Letters Patent, and that the plaintiff is now the sole owner of the said invention and Letters Patent, and of all right of action, claim and demand for infringement thereof since said assignment.

5. That the said invention is of great value and utility, and
iv that the plaintiff has been to great trouble and expense in demonstrating the utility thereof and in introducing the same into extensive commercial use in the United States and elsewhere, and that the plaintiff has granted numerous licenses for carrying on said process of ore concentration in the United States and elsewhere and said process has been and is now being extensively carried on in the United States and elsewhere and that the plaintiff is able and willing to supply the entire demand for the use of said invention by granting licenses for the use of the same conditioned on the payment of royalties measured by the output of the said process of ore concentration.

6. That the defendant has infringed the said Letters Patent since the plaintiff acquired the same, by installing apparatus for and carrying on the use of the said process of ore concentration at the town of Basin, in the County of Jefferson, State of Montana, and at the City of Butte, Silver Bow County, State of Montana, without the consent or allowance of the plaintiff, the said process of ore concentration so carried on by the defendant embodying the said invention as claimed in claims 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12 of said Letters Patent, and that the defendant is carrying on said infringement at the last named place as a continuing act and threatens to continue so to infringe.

7. That the plaintiff and another, on or about October 9, 1911, brought suit in this Court against James M. Hyde for infringement of said Letters Patent No. 835,120, and that said suit was fully
v contested on its merits and presented at length to this Court on the briefs and arguments of counsel and that this Court, in an opinion filed July 26, 1913, this Court having jurisdiction of the persons and subject matter in said suit, directed that an interlocutory decree be entered adjudging the validity of said Letters Patent and infringement thereof by the said defendant James M. Hyde as to the particular claims above charged to be infringed by the defendant herein, and directing the issuance of an injunction restraining further infringement, and a reference to a master for ascertaining profits and damages, and that on or about August 15, 1913, a decree was entered as thus directed by this Court and further proceedings have been had in accordance therewith, including the issuance of a permanent injunction restraining further infringement of said Letters Patent No. 835,120.

8. On information and belief, that the defendant herein confederated with the said James M. Hyde in the acts of infringement complained of in the said suit against the said James M. Hyde and was an actual defendant therein, and conducted the defense of said suit and paid all the expenses thereof and paid the said James M. Hyde for his services in assisting in the defense of the said suit; that the

acts decreed in the said suit to be acts of infringement were carried on under certain Letters Patent issued to said James M. Hyde on April 2, 1912, No. 1,022,085, and that since the commencement of said suit the said James M. Hyde assigned to the defendant herein all of the right, title and interest of the said James M. Hyde
vi in, to and under his said Letters Patent No. 1,022,085, for, to and in the County of Silver Bow and State of Montana; that the acts decreed in the said suit to be acts of infringement were carried on in the mill of the defendant herein and by the employees of the defendant herein and have been continued by the defendant herein in the identical apparatus used by the said James M. Hyde; and that this defendant is a joint tort feasor with the said James M. Hyde in the acts thus decreed to be infringements and is in privity with the said James M. Hyde and is bound by the said decree against the said James M. Hyde.

9. On information and belief, that, prior to the commencement of the said suit against James M. Hyde, the plaintiff caused the defendant in the present suit to be notified of the rights of the plaintiff under said Letters Patent No. 835,120, and that the defendant in this suit was duly advised of the proceedings in said suit as aforesaid, and, as will appear by the records of this Court, that the permanent injunction, above referred to, issued pursuant to said decree against the said James M. Hyde, was directed to the said James M. Hyde, his confederates and associates, and, with a copy of the said decree directing the issuance of said injunction, has been served upon the defendant in the present suit, but, nevertheless, the defendant has continued to infringe the said Letters Patent in defiance of the decree of this Court and of the injunction issued thereon and
vii to its own profit and to the damage of the plaintiff.

The plaintiff therefore prays:

I. For a permanent injunction and a preliminary injunction pending the determination of this suit, restraining the defendant, its confederates, associates, officers, servants, agents, clerks and workmen from any installation or use in any manner of the said patented invention, and particularly claims 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12 thereof, or any part thereof, in violation of the rights of the plaintiff as aforesaid, and from encouraging and inducing others to infringe the said Letters Patent, and from defending other infringers of said Letters Patent or reimbursing them the expense of defending against said Letters Patent, in whole or in part, or otherwise aiding or abetting others to install or use processes of ore concentration in infringement of said Letters Patent.

II. For costs and for an accounting of profits and damages, and that any damages assessed may be tripled.

III. For such other and further relief as the circumstances of the case may require.

MINERALS SEPARATION, LTD.,
By S. GREGORY, *Director.*

O. W. McCONNELL,
Solicitor for Complainant.
HENRY D. WILLIAMS, *Of Counsel.*

viii STATE OF NEW YORK,
County of New York, ss:

Seth Gregory, being duly sworn, deposes and says that he is a director of Minerals Separation, Limited, the plaintiff named in the foregoing Bill of Complaint; that he has read the same and knows the contents thereof, and that the same is true of his own knowledge, except as to the matters therein alleged on information and belief, and as to those matters he believes it to be true; and that he verily believes that Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot were the true, first, original and joint inventors of the invention set forth and claimed in the Letters Patent referred to in the Bill of Complaint.

S. GREGORY.

Subscribed and sworn to before me this 2nd day of October, 1913.
[SEAL.] GEO. W. SIMERS, JR.,
Notary Public, N. Y. Co.

No. 3529.

Filed: October 10, 1913. Geo. W. Sproule, Clerk.

ix And thereafter on October 15th, 1913, subpœna duly served on defendant was filed, being as follows, to-wit:

UNITED STATES OF AMERICA:

District Court of the United States, District of Montana.

In Equity.

The President of the United States of America to Butte & Superior Copper Company, Limited, Defendant, Greeting:

You are hereby commanded, That you be and appear in said District Court of the United States aforesaid, at the Court Room in Federal Building, Butte, Montana, on the 30th day of October, 1913, to answer a Bill of Complaint exhibited against you in said Court by Minerals Separation, Limited, Complainant, who is a citizen of Great Britain, and having its principal office in London, England, and to do and receive what the said Court shall have considered in that behalf. And this you are not to omit, under the penalty of five thousand dollars.

Witness, the Honorable Geo. M. Bourquin, Judge of the District Court of the United States for the District of Montana, this 10th day of October, in the year of our Lord one thousand nine
x hundred and thirteen and of our Independence the 138th.

GEO. W. SPROULE, *Clerk,*
By C. R. GARLOW,
Deputy Clerk.

Memorandum Pursuant to Rule 12, *Supreme Court U. S.*

You are hereby required, to file your answer or other defense in the Clerk's office of said court on or before the twentieth day after service, excluding the day hereof; otherwise the bill may be taken pro confesso.

[Court Seal.]

GEO. W. SPROULE, *Clerk*,
By C. R. GARLOW,
Deputy Clerk.

O. W. McConnell, Esq., Solicitor for Complainant, Helena, Montana.
Henry D. Williams, Esq., of New York City, N. Y., of Counsel.

xi UNITED STATES OF AMERICA,
District of Montana:

I hereby certify and return that I received the within Subpœna in Equity together with copy of bill of complaint, on the 13th day of October, 1913, and that on the same day I served the same on the Butte Superior Copper Company, Limited, by delivering to and leaving with J. Bruce Kremer, statutory agent for service of Defendant Company a true copy of said Subpœna in Equity, together with a true copy of bill of complaint, notice, and of affidavits of Joseph C. Pyle, H. N. Line, Thomas H. Smith, Ernest O. Jacobson, Charles F. Chandler, Floyd J. Metzger & Henry D. Williams, in said action, at Butte, Silver Bow County, in said District.
Dated this 13th day of October, 1913.

WILLIAM LINDSAY,
United States Marshal,
By GEORGE A. McKAY, *Deputy*.

Filed Oct. 15th, 1913. Geo. W. Sproule, Clerk.

xii And thereafter on the 28th day of October, 1913, the answer of defendant was filed, being as follows, to-wit:

In the District Court of the United States for the District of Mon na.

In Equity.

MINERALS SEPARATION, LIMITED, Plaintiff,

vs.

BUTTE & SUPERIOR COPPER COMPANY, LIMITED, Defendant.

Answer.

The Answer of the Butte and Superior Copper Company, Limed, ra- Defendant, to the Bill of Complaint of Plaintiff, Minerals Se tion, Limited.

The defendant now and all times saving and reserving unto self an all and all manner of benefit and advantage of exception whicher- or may be had or taken to the errors, uncertainties or other in- to, fections contained in the bill of complaint herein, for answer he to or to so much or such parts thereof as it is advised it is materi make answer unto, says as follows:

xiii

I.

This defendant admits that plaintiff is a corporation duly on- in ized and existing under and by virtue of the laws of Great Bri in and an inhabitant of Great Britain, and has its principal offic ly London, England. Admits that the defendant is a corporation nd organized and existing under the laws of the State of Arizona, te, has a regular and established place of business in the City of B ed Silver Bow County, State of Montana. Denies that it has comme e, acts or any act of infringement at said place, or at any other p or or at any time, or at all, as alleged in plaintiff's bill of complain otherwise.

II.

Admits that this suit is brought under the patent laws of he ers United States for the alleged infringement of United States Le e- Patent No. 835,120, issued November 6th, 1906, for alleged impr n- ments in ore concentration; but denies that there has been any fringement thereof by this defendant.

III.

Denies that on the 29th day of May, 1905, or at any other t e, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard d John Ballot were, within the meaning of the statutes of the Un ed States then in force, the original or first or joint inventors, or or either of them was, or that any of them were the original or firs n- joint inventors of a certain new or useful process of ore

xiv centration, or were entitled to a patent thereon under the provisions of said statutes, or that they duly filed in the United States Patent Office an application for Letters Patent of said alleged invention; denies that on the 6th day of November, 1906, all of the requirements of the statutes having been duly complied with, the said Letters Patent of the United States No. 835,120 were duly issued on said application to the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, or either; or any of them; admits that a certain alleged patent, being No. 835,120, was issued to Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot.

Denies each and every allegation contained in paragraph 3 of plaintiff's bill of complaint not hereinbefore specifically admitted or denied.

IV.

Denies that it has any knowledge or information as to whether on or about the 7th day of December, 1909, the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot duly or at all assigned to the plaintiff all right, title and interest in and to said alleged invention and alleged Letters Patent, or that plaintiff is now the sole owner of said alleged invention or Letters Patent, or of all rights of action, or claim, or demand for alleged infringement thereof since said alleged assignment.

xv V.

Defendant denies that said alleged invention is of great value or utility; denies that there was or is any invention in the said alleged patent No. 835,120; denies that it has any knowledge or information as to whether the plaintiff has been to great trouble or expense in demonstrating the alleged utility thereof, or in introducing the same into extensive commercial use in the United States or elsewhere; denies that it has any knowledge or information as to whether the plaintiff has granted numerous licenses for carrying on said alleged process of the concentration in the United States or elsewhere; denies that said alleged process has been or is now being extensively carried on in the United States, or elsewhere; denies that plaintiff has any patent upon any alleged process, and denies that plaintiff has the right to grant licenses for the use of said alleged process conditioned on the payment of royalty measured by the output of said alleged process of ore concentration, or otherwise, or at all.

Denies each and every allegation contained in paragraph 5 of plaintiff's bill of complaint not hereinbefore specifically admitted or denied.

VI.

Answering the allegations contained in paragraph 6 of plaintiff's bill of complaint, this defendant denies that it has infringed or is infringing the said alleged Letters Patent since the plaintiff acquired the same or any other time, or at all, by installing apparatus

xvi for or carrying on the use of said alleged process of ore concentration, or in any other manner, or at all, at the town of Basin, in the County of Jefferson, State of Montana, or at the City of Butte, Silver Bow County, State of Montana, or at any other place, or at all, without the consent or allowance of the plaintiff, or at all; denies that said alleged process of ore concentration alleged to have been carried on by this defendant embodied the said alleged invention as claimed in claims one (1), or two (2), or three (3), or five (5), or six (6), or seven (7), or nine (9), or ten (10), or eleven (11), or twelve (12), or any other claim of said alleged Letters Patent; denies that the defendant is carrying on any alleged infringement at the last named place, or at any other place, or at all, as a continuing or any act or threatens to continue to use said process or to infringe or threatens to infringe at all; denies that defendant has ever infringed said alleged patent.

VII.

Answering the allegations contained in paragraph 7 of plaintiff's bill of complaint, defendant admits that the plaintiff and another, on or about October 9th, 1911, brought suit in this court against James M. Hyde for alleged infringement of said Letters Patent No. 835,120, but denies that said suit was fully contested on its merits, but admits that said suit was presented at length to this Court on briefs and arguments of counsel; admits that this Court, in an xvii opinion filed July 26th, 1913, the Court having jurisdiction of the persons and subject matter in said suit, directed that an interlocutory decree be entered adjudging the validity of said Letters Patent as against James M. Hyde, and infringement thereof by said James M. Hyde, as to the particular claims herein charged to be the subject of the alleged infringement by the defendant herein; but denies that there was an adjudication of the validity of said Letters Patent as against this defendant, or that this defendant was in any manner affected by or was in any manner a party to the said alleged suit above referred to; admits that the above styled Court directed the issuance of an injunction restraining from alleged further infringement by the said James M. Hyde and a reference to a master for ascertaining profits and damages to be awarded against the said James M. Hyde, and admits that on the 15th of August, 1913, a decree was entered as directed by the said Court and that thereafter, a permanent injunction restraining the said James M. Hyde from further alleged infringement of said Letters Patent No. 835,120 was issued by the above Court. This answering defendant states that thereafter, and after the entry of said decree, James M. Hyde, the defendant in the said action above referred to, duly and regularly in compliance with the laws governing such matters and in compliance with the rules of this Court and all other Courts having jurisdiction over the said action, duly and regularly perfected an appeal in the case of xviii the above-mentioned plaintiff and another against the said James M. Hyde, and that said appeal was duly and regularly allowed by a Judge of the Circuit Court of Appeals, of the Ninth Circuit, and that said action above referred to is now on appeal, and

that the said cause will shortly be presented to the said Circuit Court of Appeals of the Ninth Circuit for final adjudication and hearing; and defendant further avers that the said patent in suit by reason of said appeal to the said Circuit Court of Appeals has not been within the meaning of the law adjudicated and that the rights of the said plaintiff above-named and the said James M. Hyde to the use of the alleged process has not been fully determined and designated by the Circuit Court of Appeals.

Further answering the allegations contained in paragraph 7, this defendant denies each and every allegation contained therein not hereinbefore specifically admitted or denied.

VIII.

Answering the allegations contained in paragraph 8 of plaintiff's bill of complaint, this defendant denies that it confederated with the said James M. Hyde, or any other person, or at all, in the alleged acts of infringement, or any act of infringement complained of in the said alleged suit against the said James M. Hyde, or at all; denies that it was an actual defendant therein, or a defendant therein at all; denies that it conducted the defense of said suit and denies that it paid all the expenses thereof, or any of the expenses thereof,
xix except as hereinafter set forth; denies that it paid the said James M. Hyde for his services in assisting in the defense of said alleged suit. This defendant avers that the said James M. Hyde paid the expenses of the defense of the said suit with the exclusive right in Silver Bow County, Montana, to the process owned by the said James M. Hyde and covered by United States Patent No. 1,022,-085, that exclusive right being granted to this defendant herein for such sum of money as was or is necessary to cover the expenses involved in the defense of the said suit. Denies that the alleged acts decreed in the said suit referred to to be acts of infringement were carried on under certain Letters Patent issued to the said James M. Hyde on April 22nd, 1912, No. 1,022,085; admits that since the commencement of the said suit of the plaintiff and another against James M. Hyde, the said James M. Hyde assigned to the defendant herein all of the right, title and interest of the said James M. Hyde in, to and under his said Letters Patent No. 1,022,085, for, to and in the County of Silver Bow and State of Montana; denies that any acts decreed in the said suit to be acts of infringement were carried on by the said defendant or that any act was carried on by the said defendant; admits that the said James M. Hyde carried on operations in the mill of the defendant and had working with him certain employees of the defendant but denies that any act in which the defendant's employees participated infringed upon the alleged patent of the plaintiff herein; denies that the defendant herein has
xx continued the use of said alleged process in the identical apparatus or any apparatus used by the said James M. Hyde, or has continued the use of said process as practised by the said James M. Hyde at all; denies that this defendant is a joint tort feasor with the said James M. Hyde in the acts alleged to have been decreed to

be infringements; denies that this defendant is in privity with the said James M. Hyde, or any other person or is bound by the said decree against the said James M. Hyde, or any other person, or is bound by any decree at all; denies that this defendant is a tort feasor at all; denies that this defendant is using the alleged process of the plaintiff above-named or the said alleged process of the said Hyde. This defendant avers that the flotation process for the concentration of ore now and heretofore practised and used by it was devised and developed by its employees; that in the devising and developing of said process neither defendant nor its employees derived any information or assistance of any kind from the said patent No. 835,120; that defendant does not and never has practised or used the flotation process described in said alleged patent of the plaintiffs, nor any flotation process in the mode described in said patent; that the apparatus described in said patent as the instrumentality for practising the alleged process set forth in said patent is inoperative, impractical and useless; that no practical, profitable or commercial result can be obtained from any operations or apparatus described in said patent.

xxi Further answering the allegations contained in paragraph 8, defendant denies each and every allegation contained in said paragraph not hereinbefore specifically admitted or denied.

IX.

Answering the allegations contained in paragraph 9, this defendant admits that prior to the commencement of said suit against James M. Hyde, the plaintiff made claims to the defendant in this suit that it claimed certain rights under said Letters Patent No. 835,120, but this defendant denies that the plaintiff in fact had any rights under said Letters Patent No. 835,120. This defendant admits that it was advised of the proceedings in the said suit of Minerals Separation, Limited, and another, against James M. Hyde; admits that the above styled Court in said action issued a permanent injunction in pursuance of said decree against the said James M. Hyde; admits that the said injunction and decree was directed to the said James M. Hyde, his confederates and associates, but denies that this defendant was at any time or is now a confederate or associate with the said James M. Hyde, and denies that it was in anywise, or at all, bound or affected by said decree or said injunction; admits that a copy of said decree was served upon this defendant; denies that this defendant has ever infringed the said Letters Patent or has continued to infringe the said Letters Patent in defiance of the decree

xxii of this Court or of the injunction issued thereon, to its own profit or to the damage of the plaintiff, or has it at any time, or at all, infringed the said Letters Patent; denies that there was ever a decree of this Court or an injunction of this Court issued which in any manner affected the above-named defendant in the use of a flotation process, or otherwise, or at all.

Denies each and every allegation contained in paragraph 9 of plaintiff's bill of complaint not hereinbefore specifically admitted or denied.

X.

Denies each and every allegation contained in plaintiff's bill of complaint not hereinbefore specifically admitted or denied.

Further answering plaintiff's bill of complaint, this defendant further says:

I.

That said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot were not the original first or true inventors of the alleged invention in ore concentration which said Letters Patent No. 835,120 purport to embrace, or of any material or substantial part thereof, but that, on the contrary, said alleged invention and all material and substantial parts thereof had before their alleged invention been fully and clearly described or claimed in the following mentioned Letters Patent:

xxiii Letters Patent of the United States.

345,951	July 20, 1886	H. Bradford.
348,157	August 24, 1886	C. J. Everson.
444,345	January 6, 1891	E. R. Gabbett.
466,753	January 5, 1892	E. A. Hockley.
469,599	February 23, 1892	A. M. Rouse.
471,174	March 22, 1892	C. B. Hebron and C. J. Everson.
474,829	May 17, 1892	C. B. Hebron.
575,669	January 19, 1897	G. Robson.
653,340	July 10, 1900	F. E. Elmore.
676,679	June 18, 1901	F. E. Elmore.
689,070	December 17, 1901	A. S. Elmore.
692,643	February 4, 1902	A. S. Elmore.
729,805	June 2, 1903	J. and L. Stoveken.
735,071	August 4, 1903	G. D. Delprat.
736,381	August 18, 1903	M. F. R. Glogner.
745,960	December 1, 1903	I. F. Good.
763,259	June 21, 1904	A. E. Cattermole.
763,260	June 21, 1904	A. E. Cattermole.
768,035	August 23, 1904	G. D. Delprat.
771,075	September 27, 1904	C. Kendall.
776,145	November 29, 1904	C. V. Potter.
777,273	December 13, 1904	A. E. Cattermole.
777,274	December 13, 1904	A. E. Cattermole.
		H. L. Sulman and H. F. Kirkpatrick-Picard.
787,814	April 18, 1905	J. D. Wolf.
788,247	April 25, 1905	A. E. Cattermole.
		H. L. Sulman and H. F. Kirkpatrick-Picard.
793,808	July 4, 1905	H. L. Sulman and H. F. Kirkpatrick-Picard.
809,959	January 16, 1906	E. B. Kirby.

xxiv Letters Patent of Great Britain.

488	February 23, 1860.....	W. Haynes.
840	January 16, 1889.....	Boulton and Gabbett.
12,778	June 4, 1902.....	Lake (Froment).

II.

Also that prior to the supposed invention or discovery of the alleged process patented in said Letters Patent No. 835,120 by said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot each and every material and substantial part of said supposed invention or discovery so patented had been invented and used by and was known to the following named persons, and was fully described in applications for Letters Patent of the United States deposited and filed by said persons in the United States Patent Office prior to the supposed invention or discovery of said alleged process set forth in said Letters Patent No. 835,120 by said Sulman, Kirkpatrick-Picard and Ballot; that said applications were so deposited and filed in the United States Patent Office and that Letters Patent of the United States were granted upon said applications as set forth below:

Morits F. R. Glogner, a resident of Freiburg, in the Kingdom of Prussia, German Empire, on January 27, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 736,381 were granted thereon upon August 18, 1903.

Israel F. Good, a resident of Allentown, Pennsylvania, on
xxv October 1, 1902, deposited and filed in the United States Patent Office, his application for Letters Patent of the United States, and that Letters Patent No. 745,960 were granted thereon upon December 1, 1903.

Guillaume D. Delprat, a resident of Broken Hill, Australia, on January 2, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 768,035 were granted thereon upon August 23, 1904.

Cosmo Kendall, a resident of Upper Norwood, Surrey, England, on July 21, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 771,075 were granted thereon upon September 27, 1904.

Charles V. Potter, a resident of Balaclava, Victoria, Australia, on January 14, 1902, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 776,145 were granted thereon upon November 29, 1904.

Arthur E. Cattermole, a resident of Highgate, London, England, on September 28, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States,

and that Letters Patent No. 777,273 were granted thereon upon December 13, 1904.

xxvi Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard, all residents of London, England, on March 29, 1904, deposited and filed in the United States Patent Office their application for Letters Patent of the United States, and that Letters Patent No. 777,274 were granted thereon upon December 13, 1904.

Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard, all residents of London, England, on March 29, 1904, deposited and filed in the United States Patent Office their application for Letters Patent of the United States, and that Letters Patent No. 788,247 were granted thereon upon April 25, 1905.

Henry L. Sulman and Hugh F. Kirkpatrick-Picard, residents of London, England, on October 5, 1903, deposited and filed in the United States Patent Office their application for Letters Patent of the United States, and that Letters Patent No. 793,808 were granted thereon upon July 4, 1905.

Alfred Schwarz, a resident of New York City, New York, on April 19, 1905, deposited and filed in the United States Patent Office, his application for Letters Patent of the United States, and that Letters Patent No. 807,501 were granted thereon upon December 19, 1905.

Alfred Schwarz, a resident of New York City, New York, on May 27, 1904, deposited and filed in the United States Patent Office, his application for Letters Patent of the United States, and that

xxvii Letters Patent No. 807,503 were granted thereon upon December 19, 1903.

Edmund B. Kirby, a resident of Rossland, Canada, on December 14, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 809,959 were granted thereon upon January 16, 1906.

Edmund B. Kirby, a resident of Rossland, Canada, on December 17, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 838,626 were granted thereon upon December 18, 1906.

Also patented or described and contained in other Letters Patent, the dates, numbers and grantees of which this defendant is not now able to specify, but prays to be allowed hereafter to add by amendment of this answer or otherwise, if it shall become necessary.

Also illustrated and described in printed publications, the names and dates of which defendant is not able to specify, but prays to be allowed hereafter to add to this answer by amendment or otherwise, if it shall become necessary.

III.

This defendant avers that for the purpose of deceiving the public the description and specification filed by the said patentees in the Patent Office was in some particulars made to contain more

xxviii than the whole truth relative to their alleged invention or discovery and more than is necessary to produce the desired effect, and that in other particulars the said description and specification was made to contain less than the whole truth relative to their alleged invention or discovery.

IV.

This defendant says that the said patentees, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot and said plaintiff herein, Minerals Separation, Limited, have admitted that the alleged invention, which said Letters Patent No. 835,120 purport to embrace, and each and every material and substantial part thereof was old and known to others prior to their alleged invention and discovery thereof, and have stated that said alleged invention was the invention of others, and that said patentees made said admissions and statements in the following described Letters Patent, and in the applications therefor and proceedings in the United States Patent Office relating thereto, and also in other patents, documents and writings:

Letters Patent of the United States.

793,808 Sulman & Kirkpatrick-Picard, application filed October 5, 1903, patented July 4, 1905.

835,143 Henry L. Sulman, application filed October 20, 1905, patented November 6, 1906.

xxix

835,479 Sulman Kirkpatrick-Picard & Ballot, application filed May 20, 1905, patented November 6, 1906.

879,985 Sulman, Kirkpatrick-Picard & Ballot, application filed February 20, 1905, patented February 25, 1908.

Letters Patent of Great Britain.

17,109 August 6, 1903, Cattermole, Sulman & Kirkpatrick-Picard.
20,419 September 22, 1903, Sulman & Kirkpatrick-Picard.
5,260 March 13, 1905, Sulman, Kirkpatrick-Pickard & Ballot.
19,709 September 19, 1905, Sulman.
26,712 December 21, 1905, Sulman, Kirkpatrick-Picard & Ballot.
23,870 October 14, 1910, Minerals Separation, Limited, and Nutter.
23,949 October 15, 1910, Nutter, Hoover and Minerals Separation, Limited.

V.

Defendant, further answering, says, that the plaintiff herein is not entitled to the relief prayed for in its bill of complaint, without this that there is any other matter, cause or thing in the said bill of complaint contained, material or necessary, for this defendant to

make answer unto, and not hereinbefore sufficiently answered,
xxx confessed or avoided, traversed or denied, is true; all of which this defendant is ready to aver, maintain and prove as this Honorable Court shall direct and prays to be hence dismissed with its costs in this behalf most wrongfully sustained.

BUTTE AND SUPERIOR COPPER COMPANY, LIMITED,
By A. B. WOLVIN, *Director.*
SHERIDAN, WILKINSON & SCOTT,
KREMER, SANDERS & KREMER,
Solicitors for Defendant.

THOMAS F. SHERIDAN,
WALTER A. SCOTT,
J. BRUCE KREMER,
Of Counsel.

UNITED STATES OF AMERICA,
District of Montana, County of Silver Bow, ss:

A. B. Wolvin, being first duly sworn on oath, deposes and says: That he is a director of Butte and Superior Copper Company, Limited, the defendant named in the foregoing answer; that he has read the same and knows the contents thereof, and that the same is true of his own knowledge, except as to the matters therein alleged
xxxi on information and belief, and as to those matters he believes it to be true. He further states that he makes this verification for and on behalf of said defendant corporation.

A. B. WOLVIN.

Subscribed and sworn to before me this 28th day of October, 1913.
[NOTARIAL SEAL.]
E. F. O'FLYNN,
Notary Public in and for the State of Montana, Residing at Butte, Montana.

My commission expires May 16th, 1914.

UNITED STATES OF AMERICA,
District of Montana, County of Silver Bow, ss:

J. Bruce Kremer, being first duly sworn on oath, deposes and says: That he is one of the solicitors for defendant in the above entitled action; that the solicitors of record for the plaintiff are Henry D. Williams, Esq., of New York City, New York, who has law offices in the City of New York, New York, and Odell W. McConnell, Esq., of Helena, Montana, who has law offices in Helena, Montana, and that for said reason it was impossible for affiant, or any solici-
xxxii tor for the defendant, personally to serve upon the said solicitors for the plaintiff the foregoing answer, and that on the 28th day of October, 1913, affiant personally served upon the said plaintiff and its solicitors the foregoing answer by depositing a true

copy thereof in the Post Office in the City of Butte, Montana, with sufficient postage prepaid thereon, said copy of said answer then and there being enclosed in an envelope and addressed to Odell W. McConnell, Esq., Attorney at Law, Helena, Montana.

J. BRUCE KREMER.

Subscribed and sworn to before me this 28th day of October, 1913.

[NOTARIAL SEAL.] E. F. O'FLYNN,

Notary Public in and for the State of Montana.

My commission expires May 16, 1914.

Filed: Oct. 28, 1913. Geo. W. Sproule, Clerk, by Harry H. Walker, Deputy.

And thereafter on March 27, 1917, the supplemental answer of defendant was filed, being as follows:

xxxiii In the District Court of the United States for the District of Montana.

In Equity

MINERALS SEPARATION, LIMITED, Plaintiff,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Supplemental Answer.

Now comes the defendant above-named, and with leave of court first had and received, files this, its supplemental answer to the bill of complaint heretofore filed by the plaintiff and complainant above-named, and alleges:

I.

That heretofore, to-wit: on the 10th day of October, 1913, the above-named plaintiff filed its bill in this court against the above-named defendant; that said complainant in effect charged that the plaintiff and defendant were both corporations and plaintiff was the owner and entitled to United States Letters Patent No. 835,120, issued on November 3rd, 1906, being a patent for improvements in ore concentration; that on the 29th day of May, 1905, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John
xxxiv Ballot, being within the meaning of the statutes of the United States then in force, the original, first and joint inventors of a new and useful process of ore concentration, did duly file in the United States Patent Office an application for Letters Patent and that Letters Patent of the United States No. 835,120 were duly issued on said application to said applicants, and that there-

after the said patent was duly assigned to the above-named plaintiff. Plaintiff alleges that the invention is of great value and that the defendant had infringed said Letters Patent and particularly claims 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12, of said patent; plaintiff further alleging that another suit was filed by the plaintiff herein and another against James M. Hyde and that the above styled court rendered a decree in favor of the above-named plaintiff and its co-plaintiff; that the said Hyde confederated with the defendant in the alleged infringement of said patent, plaintiff herein praying for a permanent injunction and an injunction pendente lite and that its patent be declared valid and for an accounting. Reference is hereby made to the original bill of complaint for a more complete statement of the contents thereof, said bill of complaint being of the records and files of this court in the above entitled action.

II.

That on or about the 28th day of October, 1913, the defendant interposed its answer to the bill of complaint wherein, after
xxxv admitting that the plaintiff is a corporation and that the suit is brought under the Patent Laws of the United States, the defendant denies each and all of the allegations of the complaint, and particularly the allegations with reference to infringement of said patent, or any of the claims thereof, the validity of each and every claim contained in said patent, and any confederation with the said defendant James M. Hyde.

III.

Further answering said bill the defendant set up as additional defense that Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot were not the original, first and true inventors of the alleged invention in ore concentration, which said Letters Patent No. 835,120 purport to embrace, or any material or substantial part thereof, because the same was fully and clearly described or claimed in the list of Letters Patent set forth in paragraph 1 of the affirmative defenses of said answer; and the said defendant set up as a further and additional defense that each and every material part of the supposed invention so claimed to have been patented and invented by Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot was known to a great number of persons and was described in applications for Letters Patent of the United States deposited by persons in the United States Patent Office prior to the supposed invention and discovery of the alleged process set forth in said Letters Patent No. 835,120, as set forth
in paragraph 2 of the affirmative defenses contained in de-
xxxvi fendant's answer, and the said defendant claimed as an affirmative defense that for the purpose of deceiving the public the description and specifications filed by the patentees in the Patent Office for said patent were in some particulars made to contain more than the whole truth relative to their alleged invention and discovery

and more than is necessary to produce the desired effect and that in other particulars the said description and specifications were made to contain less than the whole truth relative to their alleged invention or discovery as set up in paragraph 3 of the affirmative defenses of the defendant; and the said defendant set forth as a further additional defense that the said patentees aforesaid have admitted that the alleged invention, which said Letters Patent No. 835,120 purport to embrace, and each and every material and substantial part thereof, was old and known to others prior to said alleged invention and that said admissions were made in the Letters Patent as set forth in paragraph 4 of the affirmative defenses of the defendant contained in its answer. Reference is hereby made to the original answer herein filed by the defendant for a more complete statement of the contents thereof, which said answer is of the files and records of this court in the above entitled action.

IV.

That said issues became joined by the filing of said answer; that from the date of the filing of said answer the case was and
xxxvii still is at issue; that since the filing of said answer the case of Minerals Separation and another against James M. Hyde was, on appeal from the above styled court, considered by the Circuit Court of Appeals for the Ninth Circuit, and the said Circuit Court of Appeals in May, 1914, reversed and set aside the decree of the above styled court in favor of the above-named plaintiff and another and against James M. Hyde, and did declare the said Patent No. 835,120 and all of the claims thereof invalid and of no force or effect; that thereafter the said case of the above-named plaintiff and another versus James M. Hyde reached the Supreme Court of the United States through a writ of certiorari and was thereafter argued before the said Supreme Court of the United States and a decision therein rendered by the Supreme Court of the United States by which decision the decision of the Circuit Court of Appeals of the Ninth Circuit was reversed and set aside except that the said Supreme Court of the United States declared claims 9, 10 and 11 of said patent No. 835,120 invalid and of no force and effect, and that said decision so declaring said claims invalid was rendered on the 11th day of December, 1916, and that the said plaintiff was then and there and on said date duly advised of the decision and order of the said Supreme Court of the United States upon the patent aforesaid and did know that the said Supreme Court of the United States had declared each and all of said claims 9, 10 and 11 invalid and that said plaintiff has wholly failed and unreasonably neglected and delayed
xxxviii the filing of a proper or any disclaimer in writing of the matters set forth in claims 9, 10 and 11 in the Patent Office of the United States, and has wholly failed to disclaim in writing its claim to said claims 9, 10 and 11, or to any or either of them; that by reason of said unreasonable neglect and delay of the said plaintiff to disclaim in writing each and all claims to claims 9, 10 and 11, the whole of said patent No. 835,120 had become wholly

void and invalid and of no force or effect, and plaintiff cannot rely thereon nor maintain an action in equity under said patent, and that the plaintiff is now barred by reason of said unreasonable delay and neglect from any relief of any kind or nature in equity, nor can plaintiff now be given any assistance in a court of equity for any alleged invasion of its alleged rights under said patent; nor can plaintiff maintain an action for injunction or accounting and that it is estopped from any further proceedings herein by reason of its unreasonable delay and neglect to file a proper disclaimer of the claims held invalid by the Supreme Court of the United States, as aforesaid, and in accordance with the statutes of the United States of America in such cases made and provided; that said defense could not have been set forth in the original answer herein on file for the reason that the acts and things herein set forth in connection with said disclaimer were all subsequent to the date of the filing of said answer and subsequent to the 11th day of December, 1916, the date upon which the Supreme Court of the United States handed down its decision in the case of Minerals Separation and another
xxxix versus James M. Hyde; that said plaintiff has wholly failed up to this time to file any disclaimer whatsoever in the Patent Office of the United States as required by law.

V.

By way of further defense herein defendant alleges that the said plaintiff is estopped from asserting or claiming that its said alleged patent, or any claim thereof, is infringed by the use of an amount of oil exceeding five-tenths of one per cent. on the weight of the ore treated at a given time, for the reason that the said plaintiff in a judicial proceeding has stated that its invention was not practised by the use of an amount of oil in excess of five-tenths of one per cent. on the weight of the ore treated and by the further statements in a judicial proceeding that its invention was not reached until the amount of oil reached and fell below five-tenths of one per cent. on the ore treated; that each of said statements was made in a judicial proceeding in a court having jurisdiction of the subject matter since the joinder of issue in this case; that by reason of said statements the said plaintiff is now precluded and estopped from asserting in this court of equity that its invention embraces more than that described and claimed by it as aforesaid. Defendant alleges that said acts immediately last complained of did not occur until after the joinder of issue herein and the defendant did not become acquainted with the said facts until November, 1916.

xl Wherefore, defendant, having fully answered, prays to be dismissed hence with its costs.

THOMAS F. SHERIDAN,
J. BRUCE KREMER,
W. A. SCOTT,
THOS. H. SHERIDAN,
L. P. SANDERS,
ALF. C. KREMER,
Solicitors for Defendant.

xli UNITED STATES OF AMERICA,
District of Montana, County of Silver Bow, ss:

J. L. Bruce, being first duly sworn on oath, deposes and says: That he is an officer, to-wit: the Manager and also the agent of the above-named defendant, and makes this verification in said capacity for and on behalf of the above-named defendant; that he has read the foregoing supplemental answers, knows the contents thereof, and that the matters and things therein stated are true to the best of his knowledge, information and belief. J. L. BRUCE.

Subscribed and sworn to before me this 17th day of March, 1917.
[NOTARIAL SEAL.] C. H. TUOHY,
Notary Public for the State of Montana,
Residing at Butte, Montana.

My commission expires July 7th, 1918.

Filed: March 27, 1917. Geo. W. Sproule, Clerk, by H. H. Walker, Deputy.

xlii And thereafter on April 17th, 1917, the amendment to answer of defendant was filed, being as follows:

In the District Court of the United States for the District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, Plaintiff,
vs.
BUTTE & SUPERIOR MINING COMPANY, Formerly Butte & Superior Copper Company, Limited, Defendant.

Amendment to Answer.

Now comes the defendant, Butte & Superior Mining Company, and amends its answer in the above entitled suit in the following manner, to-wit:

By cancelling the paragraph numbered I beginning at Line 20, page 12, and extending to the bottom of page 13, and substituting for the cancelled passage the following:

I.

(*a*) That the supposed invention set forth in said Letters Patent, No. 835,120, had been patented and had been described in printed publications prior to the supposed invention thereof by said Sulman, Kirkpatrick-Picard and Ballot, and had been patented and
xliii described in printed publications more than two years prior to their application for a patent therefor; that said supposed invention was patented and fully described in each of the following described patents and publications, each of which patents was

granted and became a patent and each of *with* patents and publications was published as a printed publication more than two years prior to the application by said Sulman, Picard and Ballot for said patent No. 835,120:

British patent to William Haynes, No. 488, dated February 23, 1860, sealed August 17, 1860.

United States Patents.

No.	Date of patent.	Patentee.
348,157	Aug. 24, 1886	C. J. Everson.
575,669	Jan. 19, 1897	G. Robson.
469,599	Feb. 23, 1892	A. M. Rouse.

Publications.

The Daily Herald Democrat, published at Leadville, Colorado, October 30, 1889.

The Engineering and Mining Journal, published at New York City, N. Y., November 15, 1890.

(*b*) That said supposed invention was patented and fully described in each of the patents and publications set forth in paragraph (*a*) hereof and in the following described patents and publications, each of which patents was granted and became a patent, and each of which patents and publications was published as a printed publication prior to the supposed invention thereof by said Sulman, Kirkpatrick-Picard and Ballot.

xliv

No.	Date of patent.	Patentee.
736,381	Aug. 18, 1903	M. F. R. Glogner.
745,960	Dec. 1, 1903	I. F. Good.
763,259	June 21, 1904	A. E. Cattermole.
763,260	June 21, 1904	A. E. Cattermole.
763,749	June 28, 1904	G. A. Goyder and E. Laughton.
777,273	Dec. 13, 1904	A. E. Cattermole.
768,035	Aug. 23, 1904	G. A. Delprat.
777,274	Dec. 13, 1904	A. E. Cattermole, H. L. Sulman and H. F. Kirkpatrick-Picard.
784,999	Mar. 14, 1905	G. A. Goyder and E. Laughton.
776,145	Nov. 29, 1904	C. V. Potter.
787,814	Apr. 18, 1905	J. D. Wolf.
788,247	Apr. 25, 1905	H. L. Sulman, H. F. Kirkpatrick-Picard and A. E. Cattermole.

British patent to Henry Harris Lake, communicated by Alcide Froment, No. 12,778, of 1902, applied for June 4, 1902, complete specification left March 4, 1903, accepted June 4, 1903, sealed August 18, 1903.

Italian patent to Alcide Froment, Regro Genle Vole 43, No. 63,723. Regro Attes. Vol. 156, No. 166, May 20, 1902.

Publications.

xlv The California Journal of Technology for November, 1903, published at Berkeley, California, by the students in the Applied Science Colleges in the University of California, which contains upon pages 34 to 41 an article by W. F. Copeland, Drury Butler and James H. Wise, entitled "Experiments on the Elmore Process of Oil Concentration."

(*c*) That said Sulman, Kirkpatrick-Picard and Ballot were not the original or first inventors or discoverers of any material or substantial part of the thing patented in and by said patent No. 835,120, but that said supposed invention and all material and substantial parts thereof had before their alleged invention thereof been invented by the several persons named and referred to in paragraphs (*a*) and (*b*) hereof, and by them patented and described as therein set forth, and by others who fully and clearly described every material and substantial part of said supposed invention in applications filed by them in the United States Patent Office for United States patents and in Letters Patent granted by the United States, and that the following are the names of said parties, the dates of the patents granted to them, and the dates of filing of the United States patent applications in those instances where the patents were granted subsequent to the date of alleged invention by Sulman, Kirkpatrick-Picard and Ballot.

xlvi United States Patents.

No.	Date of patent.	Patentee.
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345,591	July 20, 1886	H. Bradford.
373,113	Nov. 15, 1887	Henry J. Wagner.
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466,753	Jan. 5, 1892	E. A. Hockley.
469,599	Feb. 23, 1892	A. M. Rouse.
471,174	Mar. 22, 1892	C. B. Hebron and C. J. Everson.
474,829	May 17, 1892	C. B. Hebron.
521,889	June 26, 1894	Joseph Wm. Sutton.
653,340	July 10, 1900	F. E. Elmore.
667,222	Feb. 5, 1901	John W. Ivery.
676,679	June 18, 1901	F. E. Elmore.
689,070	Dec. 17, 1901	A. S. Elmore.
692,643	Feb. 4, 1902	A. S. Elmore.
703,905	July 1, 1902	A. S. Elmore.
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770,659	Sept. 20, 1904	J. B. Scammell.
776,145	Nov. 29, 1904	C. V. Potter.

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No.	Date of patent.	Date of application.	Patentee.
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788,247	Apr. 25, 1905	Mar. 29, 1904	A. E. Cattermole, H. L. Sulman and H. F. Kirkpatrick-Picard — all of London, England.
793,808	July 4, 1905	Oct. 5, 1903	H. L. Sulman and H. F. Kirkpatrick-Picard; of London, England.
807,502	Dec. 19, 1905	May 27, 1904	A. Schwartz of New York, N. Y.
807,503	Dec. 19, 1905	May 27, 1904	A. Schwarz of New York, N. Y.
807,504	Dec. 19, 1905	Sept. 21, 1904	A. Schwarz of New York, N. Y.
807,505	Dec. 19, 1905	Oct. 14, 1904	A. Schwarz of New York, N. Y.
807,506	Dec. 19, 1905	Nov. 4, 1904	A. Schwarz of New York, N. Y.
809,959	Jan. 16, 1906	Dec. 14, 1903	Edmund B. Kirby formerly of Rossland, British Columbia, now of St. Louis, Mo.
838,626	Dec. 18, 1906	Dec. 17, 1903	Edmund B. Kirby, formerly of Rossland, British Columbia, now of St. Louis, Mo.

(*d*) That said H. L. Sulman, H. F. Kirkpatrick-Picard and John Ballot unjustly obtained said patent No. 835,120 for that which was in fact invented by others who were using reasonable diligence in adapting and perfecting the same; that said other parties filed in the United States Patent Office applications for patents fully describing the supposed invention set forth in said patent No. 835,120 and obtained patents therefor; the names of said other parties, the

xlviii dates when they filed said patent applications, the numbers of the patents so granted, and the dates when said patents were granted being as follows:

No.	Date of patent.	Date of application.	Patentee.
787,814	Apr. 18, 1905	May 22, 1903	J. D. Wolf of London, England.
788,247	Apr. 25, 1905	Mar. 29, 1904	A. E. Cattermole, H. L. Sulman and H. F. Kirkpatrick-Picard, all of London, England.
793,808	July 4, 1905	Oct. 5, 1903	H. L. Sulman and H. F. Kirkpatrick-Picard, of London, England.
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838,626	Dec. 18, 1906	Dec. 17, 1903	Edmund B. Kirby, formerly of Rossland, British Columbia, now of St. Louis, Mo.

Filed: April 17, 1917. Geo. W. Sproule, Clerk, by H. H. Walker, Deputy.

xlix And thereafter on April 17th, 1917, the answer of defendant was filed, being as follows, to-wit:

In the District Court of the United States for the District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, Plaintiff,

vs.

BUTTE & SUPERIOR COPPER COMPANY, Defendant.

Answer.

The Answer of Butte and Superior Copper Company, Limited, Defendant, to the Bill of Complaint of Plaintiff, Minerals Separation, Limited.

The defendant now and at all times saving and reserving unto itself all and all manner of benefit and advantages of exception which

can or may be had or taken to the errors, uncertainties or other imperfections contained in the bill of complaint herein, for answer-hereto, or to so much or such parts thereof as it is advised it is material to make answer unto, says as follows:

I.

This defendant admits that plaintiff is a corporation duly organized and existing under and by virtue of the laws of Great Britain and an inhabitant of Great Britain, and has its principal office in London, England, admits that the defendant is a corporation duly organized and existing under the laws of the State of Arizona, and has a regular established place of business in the City of Butte, Silver Bow County, State of Montana. Denies that it has committed acts or any act of infringement at said place, or at any place, or at any time, or at all, as alleged in plaintiff's bill of complaint, or otherwise.

II.

Admits that this suit is brought under the patent laws of the United States for the alleged infringement of the United States Letters Patent No. 835,120, issued November 6th, 1906, for alleged improvements in ore concentration; but denies that there has been any infringement thereof by this defendant.

III.

Denies that on the 29th day of May, 1905, or at any other time, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot were, within the meaning of the statutes of the United States then in force, the original or first or joint inventors, or that either of them was, or that any of them were the original or first or joint inventors of a certain new or useful process of ore concentration, or were entitled to a patent thereon under the provisions of said statutes, or that they duly filed in the United States Patent Office an application for Letters Patent of said alleged invention; denies that on the 6th day of November, 1906, all of the requirements of the statutes having been duly complied with, the said Letters Patent of the United States No. 835,120 were duly issued on said application to the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, or either, or any of them; admits that a certain alleged patent, being No. 835,120, was issued to Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot.

Denies each and every allegation contained in paragraph 3 of plaintiff's bill of complaint not hereinbefore specifically admitted or denied.

IV.

Denies that it has any knowledge or information as to whether on or about the 7th day of December, 1909, the said Henry Livingstone

Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot duly or at all assigned to the plaintiff all right, title and interest in and to said alleged invention and alleged Letters Patent, or that plaintiff is now the sole owner of said alleged invention or Letters Patent, or of all rights of action, or claim, or demand for alleged infringement thereof since said alleged assignment.

V.

Defendant denies that said alleged invention is of great value or utility; denies that there was or is any invention in the said
lii alleged patent No. 835,120; denies that it has any knowledge or information as to whether the plaintiff has been to great trouble or expense in demonstrating the alleged utility thereof, or in introducing the same into extensive commercial use in the United States or elsewhere; denies that it has any knowledge or information as to whether the plaintiff has granted numerous licenses for carrying on said alleged process of ore concentration in the United States or elsewhere; denies that said alleged process has been or is now being extensively carried on in the United States, or elsewhere; denies that plaintiff has any patent upon any alleged process, and denies that plaintiff has the right to grant licenses for the use of said alleged process conditioned on the payment of royalty measured by the output of said alleged process of ore concentration, or otherwise, or at all.

Denies each and every allegation contained in paragraph 5 of plaintiff's bill of complaint not hereinbefore specifically admitted or denied.

VI.

Answering the allegations contained in paragraph 6 of plaintiff's bill of complaint, this defendant denies that it has infringed or is infringing the said alleged Letters Patent since the plaintiff acquired the same or at any other time, or at all, by installing apparatus for or carrying on the use of said alleged process of ore concentration, or in any other manner, or at all, at the town of Basin, in the County of Jefferson, State of Montana, or at the City of Butte, Silver
liii Bow County, State of Montana, or at any other place, or at all, without the consent or allowance of the plaintiff, or at all; denies that said alleged process of ore concentration alleged to have been carried on by this defendant embodied the said alleged invention as claimed in claims one (1) or two (2), or three (3), or five (5), or six (6), or seven (7), or nine (9), or ten (10), or eleven (11), or twelve (12), or any other claim of said alleged Letters Patent; denies that the defendant is carrying on any alleged infringement at the last named place, or at any other place, or at all, as a continuing or any act or threatens to continue to use said process or to infringe or threatens to infringe at all; denies that defendant has ever infringed said alleged patent.

VII.

Answering the allegations contained in paragraph 7 of plaintiff's bill of complaint, defendant admits that the plaintiff and another, on or about October 9th, 1911, brought suit in this Court against James M. Hyde for alleged infringement of said Letters Patent No. 835,120, but denies that said suit was fully contested on its merits, but admits that said suit was presented at length to this Court on briefs and arguments of counsel; admits that this Court, in an opinion filed July 26th, 1913, the Court having jurisdiction of the persons and subject matter in said suit, directed that an interlocutory decree be entered adjudging the validity of said Letters Patent as against James M. Hyde, and infringement thereof by said James M. Hyde, as to the particular claims herein charged to be
liv the subject of the alleged infringement by the defendant herein; but denies that there was an adjudication of the validity of said Letters Patent as against this defendant, or that this defendant was in any manner affected by or was in any manner a party to the said alleged suit above referred to; admits that the above styled Court directed the issuance of an injunction restraining from alleged further infringement by the said James M. Hyde and a reference to a master for ascertaining profits and damages to be awarded against the said James M. Hyde, and admits that on the 15th of August, 1913, a decree was entered as directed by the said Court and that thereafter, a permanent injunction restraining the said James M. Hyde from further alleged infringement of said Letters Patent No. 835,120 was issued by the above Court. This answering defendant states that thereafter, and after the entry of said decree, James M. Hyde, the defendant in the said action above referred to, duly and regularly in compliance with the laws governing such matters and in compliance with the rules of this Court and all other Courts having jurisdiction over the said action, duly and regularly perfected an appeal in the case of the above named plaintiff and another against the said James M. Hyde, and that said appeal was duly and regularly allowed by a Judge of the Circuit Court of Appeals, of the Ninth Circuit, and that said action above referred to is now on appeal, and that the said cause will shortly be presented to the said Circuit Court of Appeals of the Ninth Circuit for final adjudication and hearing; and defendant further avers that the said
lv patent in suit by reason of said appeal to the said Circuit Court of Appeals has not been within the meaning of the law adjudicated and that the rights of the said plaintiff above-named and the said James M. Hyde to the use of the alleged process has not been fully determined and designated by the Circuit Court of Appeals.

Further answering the allegations contained in paragraph 7, this defendant denies each and every allegation contained therein not hereinbefore specifically admitted or denied.

VIII.

Answering the allegations contained in paragraph 8 of plaintiff's bill of complaint, this defendant denies that it confederated with the said James M. Hyde, or any other person, or at all, in the alleged acts of infringement, or any act of infringement complained of in the said alleged suit against the said James M. Hyde, or at all; denies that it was an actual defendant therein, or a defendant therein at all; denies that it conducted the defense of said suit and denies that it paid all the expenses thereof, or any of the expenses thereof, except as hereinafter set forth; denies that it paid the said James M. Hyde for his services in assisting in the defense of said alleged suit. This defendant avers that the said James M. Hyde paid the expenses of the defense of the said suit with the exclusive right in Silver Bow County, Montana, to the process owned by the said James M.
lvi Hyde and covered by United States Patent No. 1,022,085, that exclusive right being granted to this defendant herein for such sum of money as was or is necessary to cover the expenses involved in the defense of the said suit. Denies that the alleged acts decreed in the said suit referred to to be acts of infringement were carried on under certain Letters Patent issued to the said James M. Hyde on April 22d, 1912, No. 1,022,085; admits that since the commencement of the said suit of the plaintiff and another against James M. Hyde, the said James M. Hyde assigned to the defendant herein all of the right, title and interest of the said James M. Hyde in, to and under his said Letters Patent No. 1,022,085, for, to and in the County of Silver Bow and State of Montana; denies that any acts decreed in the said suit to be acts of infringement were carried on by the said defendant or that any act was carried on by the said defendant; admits that the said James M. Hyde carried on operations in the mill of the defendant and had working with him certain employees of the defendant but denies that any act in which the defendant's employees participated infringed upon the alleged patent of the plaintiff herein; denies that the defendant herein has continued the use of said alleged process in the identicau apparatus or any apparatus used by the said James M. Hyde, or has continued the use of said process as practised by the said James M. Hyde at all; denies that this defendant is a joint tort feasor with the said James M. Hyde in the acts alleged to have been decreed to be infringements; denies that this defendant is in privity with the said James M. Hyde,
lvii or any other person or is bound by the said decree against the said James M. Hyde, or any other person, or is bound by any decree at all; denies that this defendant is a tort feasor at all; denies that this defendant is using the alleged process of the plaintiff abovenamed or the said alleged process of the said Hyde. This defendant avers that the flotation process for the concentration of ore now and heretofore practised and used by it was devised and developed by its employees; that in the devising and developing of said process neither defendant nor its employees derived any information or assistance of any kind from the said patent No. 835,120; that defendant does not and never has practised or used the flotation process

described in said alleged patent of the plaintiffs, nor any flotation process in the mode described in said patent; that the apparatus described in said patent as the instrumentality for practising the alleged process set forth in said patent is inoperative, impractical and useless; that no practical, profitable or commercial result can be obtained from any operations or apparatus described in said patent.

Further answering the allegations contained in paragraph 8, defendant denies each and every allegation contained in said paragraph not hereinbefore specifically admitted or denied.

IX.

Answering the allegations contained in paragraph 9, this defendant admits that prior to the commencement of said suit against James M. Hyde, the plaintiff made claims to the defendant in
lviii this suit that it claimed certain rights under said Letters Patent No. 835,120, but this defendant denies that the plaintiff in fact had any rights under said Letters Patent No. 835,120. This defendant admits that it was advised of the proceedings in the said suit of Minerals Separation, Limited, and another, against James M. Hyde; admits that the above styled Court in said action issued a permanent injunction in pursuance of said decree against the said James M. Hyde; admits that the said injunction and decree was directed to the said James M. Hyde, his confederates and associates, but denies that this defendant was at any time or is now a confederate or associate with the said James M. Hyde, and denies that it was in anywise, or at all, bound or affected by said decree or said injunction; admits that a copy of said decree was served upon this defendant; denies that this defendant has ever infringed the said Letters Patent or has continued to infringe the said Letters Patent in defiance of the decree of this Court or of the injunction issued thereon, to its own profit or to the damage of the plaintiff, or has it at any time, or at all infringed the said Letters Patent; denies that there was ever a decree of this Court or an injunction of this Court issued which in any manner affected the above-named defendant in the use of a flotation process, or otherwise, or at all.

Denies each and every allegation contained in paragraph 9 of plaintiff's bill of complaint not hereinbefore specifically admitted or denied.

lix X.

Denies each and every allegation contained in plaintiff's bill of complaint not hereinbefore specifically admitted or denied.

Further answering plaintiff's bill of complaint, this defendant further says:

I.

(*a*) That the supposed invention set forth in said Letters Patent, No. 835,120, had been patented and had been described in printed publications prior to the supposed invention thereof by said Sulman, Kirkpatrick-Picard and Ballot, and has been patented and described in printed publications more than two years prior to their application

for a patent therefor; that said supposed invention was patented and fully described in each of the following described patents and publications, each of which patents was granted and became a patent and each of which patents and publications was published as a printed publication more than two years prior to the application by said Sulman, Picard and Ballot for said patent No. 835,120.

British patent to William Haynes, No. 488, dated February 23, 1860, sealed August 17, 1860.

United States Patents.

No.	Date of patent.	Patentee.
348,157	Aug. 24, 1886	C. J. Everson.
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469,599	Feb. 23, 1892	A. M. Rouse.

lx Publications.

The Daily Herald Democrat, published at Leadville, Colorado, October 30, 1889.

The Engineering and Mining Journal, published at New York City, N. Y., November 15, 1890.

(*b*) That said supposed invention was patented and fully described in each of the patents and publications set forth in paragraph (*a*) hereof and in the following described patents and publications, each of which patents was granted and became a patent, and each of which patents and publications was published as a printed publication prior to the supposed invention thereof by said Sulman, Kirkpatrick-Picard and Ballot.

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lxi British patent to Henry Harris Lake, communicated by Alcide Froment, No. 12,778 of 1902, applied for June 4, 1902, complete specification left March 4, 1903, accepted June 4, 1903, sealed August 18, 1903.

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The California Journal of Technology for November, 1903, published at Berkeley, California, by the students in the Applied Science College in the University of California, which contains upon pages 34 to 41 an article by W. F. Copeland, Drury Butler and James H. Wise, entitled "Experiments on the Elmore Process of Oil Concentration."

(*c*) That said Sulman, Kirkpatrick-Picard and Ballot were not the original or first inventors or discoverers of any material or substantial part of the thing patented in and by said patent No. 835,120, but that said supposed invention and all material and substantial parts thereof had before their alleged invention thereof been invented by the several persons named and referred to in paragraphs (*a*) and (*b*) hereof, and by them patented and described as therein set forth, and by others who fully and clearly described every material and substantial part of said supposed invention in applications filed by them in the United States Patent Office for United States patents and in Letters Patent granted by the United States, and that the following are the names of said parties, the dates of the pat-
lxii ents granted to them, and the dates of filing of the United States patent applications in those instances where the patents were granted subsequent to the date of alleged invention by Sulman, Kirkpatrick-Picard and Ballot;

United States Patents.

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373,113	Nov. 15, 1887	Henry J. Wagner.
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689,070	Dec. 17, 1901	A. S. Elmore.
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735,071	Aug. 4, 1903	G. D. Delprat.
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809,959	Jan. 16, 1906	Dec. 14, 1903	Edmund B. Kirby formerly of Rossland, British Columbia; now of St. Louis, Mo.
838,626	Dec. 18, 1906	Dec. 17, 1903	Edmund B. Kirby formerly of Rossland, British Columbia; now of St. Louis, Mo.

(*d*) That said H. L. Sulman, H. F. Kirkpatrick-Picard and John Ballot unjustly obtained said patent No. 835,120 for that which was in fact invented by others who were using reasonable diligence in adapting and perfecting the same; that said other parties filed in the United States Patent Office applications for patents fully
lxiv describing the supposed invention set forth in said patent No. 835,120 and obtained patents therefor; the names of said other parties, the dates when they filed said patent applications, the numbers of the patents so granted and the dates when said patents were granted being as follows:

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lxv II.

Also that prior to the supposed invention or discovery of the alleged process patented in said Letters Patent No. 835,120 by said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot each and every material and substantial part of said supposed invention or discovery so patented had been invented and used by and was known to the following named persons, and was fully described in applications for Letters Patent of the United States deposited and filed by said persons in the United States Patent Office prior to the supposed invention or discovery of said alleged process set forth in said Letters Patent No. 835,120 by said Sulman, Kirkpatrick-Picard and Ballot; that said applications were so deposited and filed in the United States Patent Office and that Letters Patent of the United States were granted upon said applications as set forth below:

Moritz F. R. Glogner, a resident of Freiburg, in the Kingdom of Prussia, German Empire, on January 27, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 736,381 were granted thereon upon Aug. 18, 1903.

Israel F. Good, a resident of Allentown, Pennsylvania, on October 1, 1902, deposited and filed in the United States Patent Office, his application for Letters Patent of the United States, and that Letters Patent No. 745,960 were granted thereon upon December 1, 1903.

lxvi Guillaume D. Delprat, a resident of Broken Hill, Australia, on January 2, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 768,035 were granted thereon upon Auguest 23, 1904.

Cosmo Kendall, a resident of Upper Norwood, Surrey, England, on July 21, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 771,075 were granted thereon upon September 27, 1904.

Charles V. Potter, a resident of Balaclava, Victoria, Australia, on January 14, 1902, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 776,145 were granted thereon upon November 29, 1904.

Arthur E. Cattermole, a resident of Highgate, London, England, on September 28, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 777,273 were granted thereon upon Dec. 13, 1904.

Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard, all residents of London, England, on March 29, 1904, deposited and filed in the United States Patent Office their application for Letters Patent of the United States, and that Letters Patent No. 777,274 were granted thereon upon December 13, 1904.

lxvii Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard, all residents of London, England, on March 29, 1904, deposited and filed in the United States Patent Office their application for Letters Patent of the United States, and that Letters Patent No. 788,247 were granted thereon upon April 25, 1905.

Henry L. Sulman and Hugh F. Kirkpatrick-Picard, residents of London, England, on October 5, 1903 deposited and filed in the United States Patent Office their application for Letters Patent of the United States, and that Letters Patent No. 793,808 were granted thereon upon July 4, 1905.

Alfred Schwarz, a resident of New York City, New York, on April 19, 1905, deposited and filed in the United States Patent Office, his application for Letters Patent of the United States, and that Letters Patent No. 807,501 were granted thereon upon December 19, 1905.

Alfred Schwarz, a resident of New York City, New York, on May 27, 1904, deposited and filed in the United States Patent Office, his application for Letters Patent of the United States, and that Letters Patent No. 807,503 were granted thereon upon December 19, 1903.

Edmund B. Kirby, a resident of Rossland, Canada, on December 14, 1903, deposited and filed in the United States Patent Office his

application for Letters Patent of the United States, and that Letters Patent No. 809,959 were granted thereon upon January 16, 1906.

lxviii Edmund B. Kirby, a resident of Rossland, Canada, on December 17, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 838,626, were granted thereon upon December 18, 1906.

Also patented or described and contained in other Letters Patent, the dates, numbers, and grantees of which this defendant is not now able to specify, but prays to be allowed hereafter to add by amendment of this answer or otherwise, if it shall become necessary.

Also illustrated and described in printed publications, the names and dates of which defendant is not able to specify, but prays to be allowed hereafter to add to this answer by amendment or otherwise, if it shall become necessary.

III.

This defendant avers that for the purpose of deceiving the public the description and specification filed by the said patentees in the Patent Office was in some particulars made to contain more than the whole truth relative to their alleged invention or discovery and more than is necessary to produce the desired effect, and that in other particulars the said description and specification was made to contain less than the whole truth relative to their alleged invention or discovery.

IV.

This defendant says that the said patentees, Henry Living-

lxix stone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot and said plaintiff herein, Minerals Separation, Limited, have admitted that the alleged invention which said Letters Patent No. 835,120 purport to embrace, and each and every material and substantial part thereof, was old and known to others prior to their alleged invention and discovery thereof, and have stated that said alleged invention was the invention of others, and that said patentees made said admissions and statements in the following described Letters Patent, and in the applications therefor and proceedings in the United States Patent Office relating thereto, and also in other patents, documents and writings.

Letters Patent of the United States.

793,808 Sulman & Kirkpatrick-Picard, application filed October 5, 1903, patented July 4, 1905.

835,143 Henry L. Sulman, application filed October 20, 1905, patented November 6, 1906.

835,479 Sulman, Kirkpatrick-Picard and Ballot, application filed May 20, 1905, patented November 6, 1906.

879,985 Sulman, Kirkpatrick-Picard & Ballot, application filed February 20, 1905, patented February 25, 1908.

Letters Patent of Great Britain.

17,109 August 6, 1903, Cattermole, Sulman & Kirkpatrick-Picard.

lxx

20,419 September 22, 1903, Sulman & Kirkpatrick-Picard.
5,260 March 13, 1905, Sulman. Kirkpatrick-Picard & Ballot.
19,709 September 19, 1905, Sulman.
26,712 December 21, 1905, Sulman, Kirkpatrick-Picard & Ballot.
23,870 October 14, 1910, Minerals Separation, Limited, and Nutter.
23,949 October 15, 1910, Nutter, Hoover, and Minerals Separation, Limited.

V.

Defendant, further answering, says that the plaintiff herein is not entitled to the relief prayed for in its bill of complaint, without this that there is any other matter, cause, or thing in the said bill of complaint contained, material or necessary for this defendant to make answer unto, and not hereinbefore sufficiently answered, confessed or avoided, traversed or denied, is true; all of which this defendant is ready to aver, maintain and prove as this Honorable Court shall direct, and prays to be hence dismised with its costs in this behalf most wrongfully sustained.

THOMAS F. SHERIDAN,
WALTER A. SCOTT,
J. BRUCE KREMER,
Solicitors for Defendant.

lxxi UNITED STATES OF AMERICA,
District of Montana, County of Silver Bow, ss:

J. L. Bruce, being first duly sworn on oath, deposes and says:

That he is an officer of the defendant, Butte and Superior Copper Company, Limited, to-wit: General Manager thereof, and makes this verification for and on behalf of defendant; that he has read the same and knows the contents thereof, and that the same is true of his own knowledge, except as to the matters therein alleged on information and belief, and as to those matters he believes it to be true.

J. L. BRUCE.

Subscribed and sworn to before me this 16th day of April, 1913.

[NOTARIAL SEAL.] C. K. TUOHY,
Notary Public in and for the State of Montana, Residing at Butte, Montana.

My commission expires July 26th, 1915.

Filed: April 17, 1917. Geo. W. Sproule, Clerk, by H. H. Walker, Deputy.

lxxii In the District Court of the United States for the District of Montana.

MINERALS SEPARATIONS, LIMITED; MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte & Superior Copper Company, Limited, Defendant.

Please take notice that on April 30th, 1917, at the opening of the Court we will move on the record and proceedings herein for leave to file the Supplemental and Amended Bill of Complaint, copy of which is annexed hereto.

April 26, 1917.

Yours, etc.,

ODELL W. McCONNELL,
HENRY D. WILLIAMS,
Solicitor and of Counsel for Plaintiffs.

lxxiii To J. Bruce Kremer, Esq.; Walter A. Scott, Esq.; Thomas F. Sheridan, Esq., Attorneys and of Counsel for Defendant.

(Copy received Apr. 26, 1917.)

THOMAS F. SHERIDAN,
Of Solicitor- for Defendant.

And thereafter on May 1st, 1917, the supplemental and amended bill of complaint of plaintiffs was filed, being as follows, to-wit:

lxxiv In the District Court of the United States for the District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED; MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Supplemental and Amended Bill of Complaint.

Now comes the plaintiffs above named, and, with leave of Court first had and received, file this their Supplemental and Amended Bill of Complaint and allege by way of Supplement and Amendment:

1. That heretofore, to-wit, on the 10th day of October, 1913,
lxxv the plaintiff Minerals Separation, Limited, filed its bill in this court, alleging the issue and its ownership, of Letters Patent 835,120 and infringement by the above named defendant, and the suit of said plaintiff and another against James M. Hyde and participation therein by the defendant here and the conduct of the defendant here so as to be estopped thereby, and praying for an injunction and accounting of profits and damages, and that said defendant filed an Answer and Amended Answers thereto. Reference is here made to said Bill and Answers for a more complete statement of the contents thereof.

2. That the plaintiff, Minerals Separation American Syndicate, Limited, is a corporation duly organized and existing under and by virtue of the laws of Great Britain and having its principal office in London, England, and that the plaintiff, Minerals Separation North American Corporation, is a corporation duly organized and existing under and by virtue of the laws of the State of Maryland having its principal office and place of business in the Continental Building in the City of Baltimore in the State of Maryland.

3. That by an instrument in writing dated the tenth day of October, 1910, (which, or a duly certified copy thereof, the plaintiffs will produce as the Court may direct) Minerals Separation, Limited, plaintiff, granted to Minerals Separation American Syndicate Limited, plaintiff (together with other things) the sole and exclusive right, license, power and authority to apply, use and exercise in the United States of America, the invention and process of said Letters Patent No. 835,120 for the term of two years, with the privi-
lxxvi lege of extension for a further period of one year; that said privilege of extension was exercised, and that said exclusive license expired by affluxion of time on the tenth day of October, 1913; that by an instrument in writing dated the eighth day of July, 1913 (which, or a duly certified copy thereof, the plaintiffs will produce as the Court may direct, and a copy of which is annexed hereto as Exhibit A), Minerals Separation Limited, plaintiff, entered into an agreement of sale and purchase with Minerals Separation American Syndicate (1913) Limited, a corporation duly organized and existing under and by virtue of the laws of Great Britain, by which Minerals Separation, Limited, agreed to sell and Minerals Separation American Syndicate (1913) Limited agreed to purchase (along with other things) the entire beneficial interest in the said Letters Patent 835,120, the purchase to be completed on or before the tenth day of October, 1913; that by mutual arrangement the completion of the purchase by the assignment of the said Letters Patent 835,120 (and others) was deferred pending the litigation against James M. Hyde and other litigation; that by mutual arrangement the completion of the payment of the full consideration to Minerals Separation, Limited, plaintiff, was deferred until on or about the sixth day of October, 1916, and thereupon the entire beneficial interest in said Letters Patent 835,120 vested in said Minerals Separation American Syndicate (1913) Limited; that by an instrument in writing dated the 7th day of December, 1916 (which, or a duly certified copy thereof the plaintiffs will produce as the Court may direct, and

lxxvii a copy of which is annexed hereto as exhibit B) Minerals Separation American Syndicate (1913) Limited sold, assigned and transferred to Minerals Separation North American Corporation, plaintiff, all the right, title and interest in and to said Letters Patent 835,120 to which it then was, or might thereafter become entitled, and all moneys due and to grow due, royalties due and to grow due, claims and demands and things in action, of Minerals Separation American Syndicate (1913) Limited; that by virtue of the premises the plaintiffs became and now are the sole owners of said Letters Patent 835,120 and of all claims and demands and rights of action for profits and damages for infringements of said Letters Patent from the date of issue thereof.

4. That in the suit of Minerals Separation, Limited, and another against James M. Hyde, referred to in paragraph 7 of the Bill of Complaint, the Circuit Court of Appeals of the Ninth Circuit in May, 1914, entered its decree reversing the decree of this Court; that thereafter on the 13th day of January, 1917, the Supreme Court of the United States issued its Mandate reversing the decree of the Circuit Court of Appeals of the Ninth Circuit and modifying and affirming the decree of this Court and directing the entry of a decree holding claims 1, 2, 3, 5, 6, 7, and 12 of said Letters Patent 835,120 valid and infringed and claims 9, 10, and 11 invalid, as appears by said Mandate on file in this Court, a copy of which is annexed hereto as Exhibit C.

5. That on the 28th day of March, 1917, Minerals Separation, Limited, plaintiff, as the sole assignee of the patentees of said
lxxviii Letters Patent 835,120 for the whole of the United States and the territories and possessions thereof, in view of the aforesaid decision and Mandate of the Supreme Court of the United States, and under and pursuant to the laws for such case made and provided, and without unreasonable neglect or delay, entered its disclaimer or so much of the thing patented by claims 9, 10 and 11 of said Letters Patent 835,120 as it did not choose to hold or claim by virtue of said Letters Patent, all as appears by said disclaimer a certified copy of which is ready here in Court to be produced as the Court may direct, and a copy of which is hereto annexed as Exhibit D.

6. That on the 16th day of April, 1917, plaintiffs there waiving accounting and filing proof of said disclaimer and not asking for costs, a final decree was entered in said suit of Minerals Separation, Limited, and another, against James M. Hyde, decreeing the validity of claims 1, 2, 3, 5, 6, 7 and 12 of said Letters Patent 835,120, and infringement thereof by defendant, and a perpetual injunction, as appears by the said decree on file in this court, a certified copy of which is ready to be produced as the court may direct, and a copy of which is annexed hereto as exhibit E.

7. That the processes recited in claims 9, 10 and 11 of said Letters Patent 835,120 as limited by said disclaimer were new and original inventions of the patentees thereof, and that said claims 9, 10 and 11 of said Letters Patent, 835,120 as limited by said disclaimer are good and valid, and that the Butte and Superior Mining Company, defendant, subsequent to the issue of said Letters Patent 835,120 and

lxxix prior to the filing of the Bill of Complaint herein and without the license and allowance of the plaintiffs or either of them, employed processes of concentrating powdered ores embodying and containing said invention or inventions in infringement of said claims 9, 10 and 11 of said Letters Patent 835,120 as limited by said disclaimer, as well as the invention or inventions of claims 1, 2, 3, 5, 6, 7 and 12 of said Letters Patent, and continues so to do, and has encouraged and induced others so to infringe.

And plaintiffs allege by way of amendment to and in substitution of paragraph 8 of the Bill of Complaint:

8. On information and belief, that prior to the beginning of the acts of infringement complained of in said suit of Minerals Separation, Limited, and another, against James M. Hyde, the Butte and Superior Mining Company, defendant here, invited said James M. Hyde to test the applicability of flotation to the ores of the Butte and Superior Mining Company; that thereafter Butte and Superior Mining Company investigated through its own attorneys and counsel the matter of infringement of the patents of Minerals Separation, Limited, by such application, and thereafter entered into an agreement with said James M. Hyde whereby Hyde was to give his knowledge and time to working out such application of flotation to the ores of the Butte and Superior Mining Company and was to superintend the erection and operation of a plant to that end and was to be paid expenses and to have a large additional payment if the enterprise succeeded, and that it was further agreed between said Butte and Superior Mining Company and said Hyde that said Butte and Superior Mining

lxxx Company would defend said Hyde and hold him harmless in case he should be sued by Minerals Separation, Limited, for infringement by reason of the erection and operation of such plant for said Butte and Superior Mining Company; that the acts of said Hyde complained of in said suit of Minerals Separation, Limited, and another against James M. Hyde as the acts of infringement there, consisted in the operation of the plant so erected and operated by said Hyde for the said Butte and Superior Mining Company; that said acts of infringement by Hyde were conducted in the mill of the said Butte and Superior Mining Company, with apparatus and ingredients belonging to the said Company, upon the ore of said Company, and for the benefit and advantage of the said company; that the said acts of infringement by Hyde were conducted by the employees of the Butte and Superior Mining Company under the superintendence of Hyde and that in those operations Hyde was himself an employee of the said company; that the Butte and Superior Mining Company conducted and controlled the defense from the beginning to the end of said suit of Minerals Separation, Limited, and another, against James M. Hyde, and paid all the expenses thereof and paid the said James M. Hyde for his expenses in assisting in the defense of said suit; that subsequent to the beginning of the said suit of Minerals Separation, Limited, and another, against Hyde the latter applied for and subsequently obtained a patent No. 1,022,085 for certain features involved in the said operations in the mill of Butte and Superior Mining Company charged as the act of infringement

lxxxi there, but said patent was granted and issued for what was not the invention of said Hyde or any invention over the art and the application for said patent was an after thought and a sham and a device to aid in the defense of said suit; that long subsequently and after the said suit was argued at final hearing in this court the said Hyde granted to said Butte and Superior Mining Company an exclusive license under said patent for the County of Silver Bow, State of Montana, for and in consideration of said company's paying all the expenses of the defense of said suit and holding Hyde harmless therein, but said license was without value and said consideration was paid for nothing and the transaction was an after thought and a sham and a device to avoid the legal effect of the actual relation of Butte and Superior Mining Company to the defense of said suit; that the process introduced by said Hyde into the Butte and Superior Mining Company's plant was continued in use by the said company, the defendant here, by and through other employees and under other superintendence and in other plants; that to the extent that the said Hyde was concerned in the said operations decreed in said Hyde suit to be an infringement of said Letters Patent 835,120 this defendant was the master and the principal and was a joint tort feasor with said Hyde; that the defendant here conducted the defense of Hyde in said suit against Hyde for its own protection here and with the knowledge of the plaintiffs and has had its day in court, in so far as concerns the issues there raised and determined, and is bound by the said final decree entered against the said James M. Hyde in said case on April 16th, 1917, to that extent, that is to say, to the extent that the lxxxii Letters Patent in suit No. 835,120 are valid as to claims 1, 2, 3, 5, 6, 7 and 12, and were infringed by the acts and operations there complained of.

And plaintiffs allege by way of further Supplement:

9. That the aforesaid final decree entered on April 16th, 1917, in said suit of Minerals Separation, Limited, against James M. Hyde is final and determinative against the defendant here as to the issue of validity of claims 1, 2, 3, 5, 6, 7 and 12 of said Letters Patent 835,120, and as to the issue of infringement of said claims by the acts and operations there complained of.

The plaintiffs therefore pray:

I. For a permanent injunction and an injunction pendente lite restraining the defendant, its confederates, associates, officers, servants, agents, clerks and workmen from any installation or use in any manner of the said patented invention and particularly claims 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12 thereof, or any part thereof, in violation of the rights of the plaintiffs as aforesaid, and from encouraging and inducing others to infringe the said Letters Patent, and from defending other infringers of said Letters Patent or reimbursing them the expense of defending against said Letters Patent, in whole or in part, or otherwise aiding or abetting others to install or use processes of ore concentration in infringement of said Letters Patent.

II. For an accounting of profits and damages and that any damages assessed may be tripled.

III. For such other and further relief as the circumstances of the case may require.

MINERALS SEPARATION, LTD.,
By JOHN BALLOT, *Chairman.*
lxxxiii MINERALS SEPARATION AMERICAN SYNDICATE, LTD.,
By JOHN BALLOT, *Chairman.*
MINERALS SEPARATION NORTH AMERICAN CORPORATION,
By JOHN BALLOT, *President.*

HENRY D. WILLIAMS,
WM. HOUSTON KENYON,
Of Counsel.
ODELL W. McCONNELL,
Solicitor and of Counsel.

UNITED STATES OF AMERICA,
State of Montana,
County of Silver Bow, ss:

John Ballot, being duly sworn, deposes and says:

That he is Chairman of the Board of Directors of Minerals Separation, Limited, one of the plaintiffs named in the foregoing Supplemental and Amended Bill of Complaint, and that he is Chairman of Minerals Separation American Syndicate, Limited, another one of the said plaintiffs, and that he is also President of Minerals Separation North American Corporation, the third other plaintiff named in the foregoing Supplemental and Amended Bill of Complaint; that he has read the same, and knows the contents thereof, and that the same is true of his own knowledge, except as to the matters therein
lxxxiv alleged on information and belief, and as to those matters he believes it to be true.

——— ———.

Subscribed and sworn to before me this 26th day of April, 1917.
[NOTARIAL SEAL.] JOHN G. BAILEY,
A Notary Public in and for the State of Montana, Residing at Butte, Montana.

My commission expires 12-10-1917.

EXHIBIT "A."

Agreement of July 8, 1913, Between Minerals Separation, Limited, and Minerals Separation American Syndicate (1913), Limited.

An agreement made the eighth day of July, One Thousand Nine Hundred and Thirteen between Minerals Separation Limited having its registered office at 62 London Wall in the City of London (hereinafter called the company) of the one part and Minerals Separation

American Syndicate (1913) Limited having its registered office at 62 London Wall aforesaid (hereinafter called the Syndicate) of the other part.

lxxxv Whereas the Syndicate was incorporated on the twenty-seventh day of June One Thousand Nine Hundred and thirteen under the Companies (Consolidation) Act 1908 with a nominal capital of Two hundred and fifty thousand pounds divided into One hundred and twenty-five thousand A shares of One pound each and Two hundred and fifty thousand B shares of Ten shillings each; and whereas by Clause 2 of the Articles of Association of the Syndicate it is provided that the Syndicate shall enter into the Agreement therein referred to being this Agreement now it is hereby agreed as follows:

1. The Company shall sell and the Syndicate shall purchase:

First. The letters patent and rights mentioned in the schedule hereto but subject to certain licenses granted by the company the dates of which and the names of the licensees mentioned therein are as follows:

(A) Twenty-fifth June One thousand nine hundred and twelve, The Cuba Copper Company.

(B) Nineteenth November, One thousand nine hundred and twelve, Britannia Mining and Smelting Company, Limited, as modified by letter dated seventeenth December One thousand nine hundred and twelve from the Company to the said Britannia Mining and Smelting Company Limited.

(C) Sixteenth January One thousand nine hundred and thirteen the Silverton Mines Limited and Robert Insinger.

(D) Twenty-seventh February One thousand nine hundred and thirteen the Ducktown Sulphur & Copper and Iron Company Limited.

lxxxvi (E) Tenth April One thousand nine hundred and thirteen The Inspiration Consolidated Copper Company.

(F) Seventh May One thousand nine hundred and thirteen The Elm Orlu Mining Company.

(G) Seventh May One thousand nine hundred and thirteen The Colusa Parrot Mining and Smelting Company.

(H) Thirteenth May One thousand nine hundred and thirteen William B. McDonald and Louis S. Nobel.

Secondly. The benefit and rights of the Company of and under the said licenses and of any other licenses that may be granted prior to the completion of the purchase and Thirdly:—the exclusive right so far as the company can confer the same to apply for and obtain in the Republic of Cuba and the Philippine Islands patents in connection with any of the inventions comprised in the letters patent and applications mentioned in the schedule hereto and generally in connection with processes and apparatus for separating different pulverulent materials by oil selection gaseous flotation or other surface tension phenomena.

2. Part of the consideration for the said sale shall be the sum of Ninety three thousand seven hundred and fifty pounds which shall be paid and satisfied by the allotment to the company or its nominee

or nominees of One hundred and eighty seven thousand five hundred fully paid B shares of Ten shillings each in the Capital of the Syndicate.

3. As the residue of the consideration for the said sale the Syndicate shall indemnify the Company against all liability and obligations of the Company under or in respect of any of the li-
lxxxvii censes granted by them and particulars of which are set out in Clause 1 hereof and shall also indemnify the Company against all liability and obligations of the Company under or in respect of all costs and charges already or hereafter to be incurred by the Company in connection with applying for and taking out patents in the said Republic of Cuba and the Syndicate shall further indemnify the Company against the liabilities of the Company under a letter dated second day of March One thousand nine hundred and ten from the company to one James M. Hyde and against all sums which the Company may have been ordered and may be ordered to pay to the said James M. Hyde in connection with certain litigation pending between the company and the said James M. Hyde in the United States of America and against the costs, charges and expenses of the Company in connection with the said litigation and the Syndicate shall at once repay to the Company all disbursements already made by the Company on account thereof or in connection therewith. The Syndicate shall be entitled to receive all damages and any other profits or benefits which may be derived from or in connection with the said litigation.

The purchase shall be completed on or before the tenth day of October One thousand nine hundred and thirteen at the registered office of the Syndicate when One hundred and thirty seven thousand five hundred fully paid B shares of Ten shillings each in the Capital of the Syndicate part of the said One hundred and eighty seven thousand five hundred fully paid B shares shall be allotted the Company or its nominees and the Company and all other necessary
lxxxviii parties if any shall at the expense of the Syndicate, execute and do all assurances and things for vesting in the Syndicate or as it shall direct the premises mentioned in the schedule hereto and giving to the Syndicate the full benefit of this Agreement as shall be reasonably required. As to fifty thousand fully paid B shares of Ten shillings each in the Capital of the Syndicate the balance of the said One hundred and eighty seven thousand five hundred B shares the same shall be allotted to the Company or its nominees at the rate of Two shares for every one "A" share of one pound each in the initial capital of the Syndicate part of the last twenty five thousand A shares in such capital which shall be hereafter allotted that is to say when one of such "A" shares shall be allotted there shall be allotted to the company or its nominees Two of such fully paid "B" shares. No new shares in the Capital of the Syndicate shall be created or issues until the whole of the shares in the initial capital of the Syndicate shall have been allotted.

5. The Company shall with all convenient speed and at cost price communicate to the Syndicate or its assigns all improvements, additions and new discoveries which it shall make or acquire or be inter-

ested in either alone or jointly with others in connection with any of the inventions comprised in the letters patent mentioned in the schedule hereto and generally in connection with processes and apparatus for separating pulverulent materials by oil selection gaseous flotation or other surface tension phenomena and shall give to the Syndicate or its assigns as full information as may be pos-
lxxxix sible as to the exact mode of working and using such improvements, additions and new discoveries but any plans, drawings and models required by the Syndicate or its assigns in connection therewith shall be furnished to the Syndicate or its assigns on payment of out of pocket expenses — of the Syndicate or its assigns execute and do all such documents and things as may be requisite for enabling the Syndicate or its assigns to obtain letters patent in the United States of America and the Dominion of Canada, the Republic of Mexico and the Republic of Cuba and the Philippine Islands for such improvements, additions and new discoveries.

6. The Syndicate shall with all convenient speed and at cost price communicate to the Company or its assigns all improvements, additions and new discoveries which it shall make or acquire or be interested in either alone or jointly with others in connection with any of the inventions comprised in the letters patent and applications mentioned in the schedule hereto and generally in connection with processes and apparatus for separating different pulverulent materials by oil selection gaseous flotation or other surface tension phenomena and shall give to the company or its assigns as full information as possible as to the exact mode of working and using such improvements, additions and new discoveries but any plans, drawings and models required by the Company or its assigns in connection therewith shall be furnished to the Company or its assigns on payment of out of pocket expenses and shall from time to time at the request and at the expense of the company or its assigns execute and do all such documents and things as may be requisite for enabling the
xc company or its assigns to obtain letters patent elsewhere than in the United States of America, the Dominion of Canada, the Republic of Mexico, the Republic of Cuba and the Philippine Islands, for such improvements, additions and new discoveries.

7. The Syndicate shall not dispute the validity of any of the patents and patent rights for the time being belonging to the Company nor in any manner support any litigation against the Company. The Company and the Syndicate shall mutually assist each other as far as possible (except financially) in all litigation against infringers or alleged infringers of the said Letters Patent or in respect of Letters Patent which may from time to time be held by or belong to either of them. The Company and the Syndicate shall also mutually assist each other in negotiating for the acquisition upon the best possible terms of new inventions and discoveries and patents for the same or improvements thereof by third parties which it may be considered desirable either to acquire or control in the United States of America, the Dominion of Canada, the Republic of Mexico, the Republic of Cuba, or the Philippine Islands or any other part of the world.

8. The Syndicate shall pay all the costs, charges and expenses of and incident to the preparation and execution of this agreement and of the Syndicate's memorandum and Articles of Association and shall also pay all stamp fees and legal and other expenses incident to the formation and registration of the Syndicate.

9. The Syndicate shall cause this Agreement to be duly filed with the Registrar of Companies pursuant to Section 88 of the
xci Companies (Consolidation) Act 1908 and also in the case of shares allotted to nominee shall cause a sufficient contract to be filed constituting the title of such nominees.

In Witness Whereof the Companies parties hereto have caused their respective common seals to be hereto affixed the day and year first above written.

The Schedule Above Referred To.

Part 1.

1. The benefit of the following Letters Patent granted in respect of the United States of America.

No.	Date.	Name.
777,273	13–12–04	Cattermole.
763,259	21– 6–04	ditto.
763,260	21– 6–04	ditto.
809,959	16– 1–06	E. B. Kirby.
838,626	18–12–06	ditto.
763,749	28– 6–04	Goyder & Laughton.
784,999	14– 3–05	ditto.
864,597	27– 8–07	De Bavay.
912,783	27– 8–07	ditto.
776,145	29–11–04	C. V. Potter.
1,045,970	3–12–12	Potter's S. O. T. Co.
ser.		
683,005	11– 3–12	L. Bradford.
793,808	4– 7–05	Sulman & Picard.
788,247	25– 4–05	Cattermole, Sulman & Picard.
777,274	13–12–04	ditto.
xcii		
879,985	25– 2–08	H. L. Sulman.
835,120	6–11–06	Sulman, Picard & Ballot.
835,143	6–11–06	H. L. Sulman.
835,479	6–11–06	Sulman, Picard & Ballot.
902,018	27–10–08	H. L. Sulman & E. A. Sulman.
962,678	28– 6–10	Greenway, Sulman & Higgins.
953,746	5– 4–10	T. J. Hoover.
ser.		
587,621	17–10–10	Greenway & Lavers.
ser.		
647,239	1– 9–11	Nutter & Lavers.

No.	Date.	Name.
ser. 636,245	30– 6–11	H. H. Greenway.
ser. 635,900	4–12–11	E. H. Nutter.
ser. 651,188	25– 9–11	Nutter & Hoover.
ser. 712,319	30– 7–12	Chapman & Tucker.
ser. 723,327	1–10–12	J. Hebbard.
738,583	26–12–12	Chapman & Tucker.
ser. 732,386	19–12–11	A. C. Howard.
955,012	12– 5–10	H. L. Sulman.
979,857	27–12–10	T. J. Hoover. Broadbridge & Howard.
ser. 768,374	17– 4–13	Greenway & Lowry.
ser. 766,250	8– 5–13	Chapman.

xciii 2. The benefit of all extensions and prolongations of the terms and privileges granted by any such patents as aforesaid.

Part 2.

1. The benefit of the following Letters Patent granted in respect to the Dominion of Canada viz:

No.	Date.	Name.
87,785	14- 6-04	Cattermole.
87,786	14- 6-04	ditto.
76,621	8- 7-02	C. V. Potter.
121,676	2-11-09	Potter S. O. T. Co. (T. J. Greenway).
169,146	13- 3-12	ditto.
87,700	7- 6-04	Sulman & Picard.
94,516	1- 8-05	Cattermole, Sulman & Picard.
96,183	21-11-05	Sulman, Picard & Ballot.
96,182	21-11-05	ditto.
99,743	26- 6-06	ditto.
127,397	9- 8-10	Greenway, Sulman & Higgins.
129,819	13-12-10	T. J. Hoover.
134,271	11- 7-11	Greenway & Lavers.
135,089	22- 8-11	Sulman & Picard.
137,404	19-12-11	Nutter & Lavers.
142,607	3- 9-12	H. H. Greenway.
ser. 166,434	18-11-11	Nutter & Hoover.
147,431	22- 4-13	Chapman & Tucker.
ser. 176,341	17- 1-13	J. Hebbard.

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No.	Date.	Name.
ser.		
175,775	26-12-12	Chapman & Tucker.
147,432	22- 4-13	A. C. Howard.
94,718	15- 8-05	S. S. & Steele.
129,820	13-12-10	T. J. Hoover.
ser.		Broadbridge & Howard.
179,523	21- 5-13	Greenway & Lowry.

2. The benefit of all extensions and prolongations of terms and privileges granted by any such patents as aforesaid.

Part 3.

1. The benefit of the following Letters Patent granted in respect of the Republic of Mexico.

No.	Date.	Name.
3,397	15-12-03	Cattermole.
4,268	12- 1-05	De Bavay.
4,267	12- 1-05	ditto.
4,269	12- 1-05	ditto.
3,605	24- 3-04	C. V. Potter.
9,362	14- 7-09	Potter S. O. T. Co.
12,781	12- 3-12	Potter S. O. T. Co.
3,276	12- 4-04	Cattermole, Sulman & Picard.
4,908	14- 9-05	Sulman, Picard & Ballot.
5,560	21- 4-06	ditto.
4,907	14- 9-05	ditto.
5,561	21- 4-06	ditto.
4,622	27- 5-05	S. Steele & Steele.
4,635	1- 6-05	ditto.

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5,603	26- 4-06	Sulman, Picard & Ballot.
5,602	26- 4-06	ditto.
9,422	26- 7-09	Minerals Separation Ld.
9,592	9- 9-09	ditto.
11,087	19-10-10	ditto.
11,898	20- 7-11	ditto.
11,943	6- 7-11	ditto.
12,291	31-10-11	ditto.
12,050	11- 8-11	ditto.
12,290	31-10-11	ditto.
13,316	14- 8-12	ditto.
13,820	8- 1-13	ditto.
13,749	17-12-12	ditto.
13,991	6- 3-13	ditto.
		Broadbridge & Howard.
		Greenway & Lowry.

2. The benefit of all extensions and prolongations of the terms and privileges granted by any such patents as aforesaid.

Part 4.

1. The benefit of the following letters patent and application for Letters Patent granted in respect of the Republic of Cuba, viz:

No.	Date.	Name.
1,521	2-5-11	Minerals Separation Limited.
1,520	2-5-11	ditto.
Application for patent filed 26-3-13.		ditto.

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2. The benefit of all extensions and prolongations of the terms and privileges granted by any such patents as aforesaid.

The Common seal of Minerals Separation Ltd. was hereto affixed in the presence of

JOHN BALLOT,
W. W. WEBSTER,
Directors.

E. WILLIAMS, *Secretary.* [SEAL.]

The Common Seal of Minerals Separation American Syndicate (1913) Limited was hereto affixed in the presence of

EMIL BEER,
H. A. KROHN,
Directors.

E. WILLIAMS, *Secretary.* [SEAL.]

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EXHIBIT "B."

Bill of Sale from Minerals Separation American Syndicate (1913), *Limited, to Minerals Separation North American Corporation.*

Know all men by these presents that Minerals Separation American Syndicate (1913) Limited, a company incorporated under the Companies Consolidated Act 1908, having its registered office at No. 61 London Wall, in the city of London, England, for and in consideration of five hundred thousand (500,000) shares, without nominal or par value, of the stock of Minerals Separation North American Corporation, a corporation duly organized and existing under the laws of the State of Maryland, whose principal office is in the Continental Building, in the City of Baltimore, in the State of Maryland, of the assumption by said Minerals Separation North American Corporation of all the debts, liabilities and obligations, contractual or otherwise, of said Minerals Separation American Syndicate (1913), Limited, and for other valuable considera-

xcviii tions to it moving by said Minerals Separation North American Corporation, the receipt whereof is hereby acknowledged,

has bargained, sold, assigned, transferred and set over, and by these presents does bargain, sell, assign, transfer and set over to said Minerals Separation North American Corporation, all the patents (subject, however, to all licenses, rights and options heretofore granted in respect thereto), processes, licenses, inventions, applications for patents and all rights, contracts, agreements, concessions, privileges, shares of the capital stock of corporations now owned by said Minerals Separation American Syndicate (1913), Limited, and all the right, title and interest in and to patents (subject, however, to all licenses, rights and options heretofore granted in respect thereto), processes, licenses, inventions and applications for patents, and all rights, contracts, agreements, concessions, privileges, shares of the capital stock of corporations to which said Minerals Separation American Syndicate (1913) Limited, is now or to which it shall hereafter become entitled by virtue of any existing agreements or otherwise, and all the cash on hand and in banks, whether in the Kingdom of Great Britain, the United States of America, or elsewhere, promissory notes, bills of exchange, drafts, outstanding accounts, bills receivable, moneys due and to grow due, royalties due and to grow due, claims and demands and things in action, office furniture and fixtures and other chattels, and all the business, property and assets of Minerals Separation American Syndicate (1913), Limited, of every sort, nature or description, including the good will of its business as a going concern;

xcix To have and hold the same unto Minerals Separation North American Corporation, its successors and assigns, to its and their own use absolutely and forever; subject, however, to the payments, discharges and performances as the case may be, of all the debts, liabilities and obligations, contractual or otherwise, of Minerals Separation American Syndicate (1913), Limited.

And for the considerations aforesaid, said Minerals Separation American Syndicate (1913), Limited, covenants and agrees with said Minerals Separation North American Corporation and its successors and with all and every person or persons whomsoever lawfully or equitably deriving any estate, right, title or interest of, in or to the property hereby sold, assigned and transferred, that it shall and will at any time or from time to time hereafter, upon request of said Minerals Separation North American Corporation, its successors or assigns, but at the cost and expense of said Minerals Separation North American Corporation, its successors or assigns, make, do, execute, acknowledge or deliver, or cause to be made, done, executed, acknowledged or delivered, all and every such further and other lawful acts, deeds, bills of sale, transfers, assignments and assurances in the law, whether in the United States of America, Kingdom of Great Britain or any other country, for the better and more effectual vesting and confirming the property hereby bargained, sold, assigned, transferred and set over, or so intended to be, in and to said Minerals Separation North American Corporation, its successors and assigns forever, as by said Minerals Separation North American Cor-

c poration, its successors or assigns, or its or their counsel learned in the law shall be reasonably advised or required.

Annexed hereto, marked "A" and made part hereof, is a partial list of the patents and applications either owned by the Minerals Separation American Syndicate (1913), Limited, the vendor corporation, or in or to which it has any right, title or interest, and which is part of the property hereby transferred or intended so to be.

Annexed hereto and made part hereof and marked "B" is a partial list of the licenses granted in respect of the patents either owned by the Minerals Separation American Syndicate (1913), Limited, the vendor corporation, or in which patents it has any right, title or interest.

In witness whereof, Minerals Separation American Syndicate (1913), Limited, has caused its name to be hereto affixed in fact, under and by virtue of a Power of Attorney dated October 11, 1916.

MINERALS SEPARATION AMERICAN SYNDICATE (1913), LIMITED,
By JOHN BALLOT,
Its Attorney in Fact.

ci STATE OF MARYLAND,
City of Baltimore, ss:

On December 17th, 1916, before me personally came John Ballot, the Attorney-in-Fact of Minerals Separation American Syndicate (1913), Limited, a Company organized under the laws of Great Britain, to me personally known and known to me to be the individual described in and who as such Attorney executed the within instrument and acknowledged that he executed the same as the act and deed of Minerals Separation American Syndicate (1913), Limited, therein described by virtue of a Power of Attorney duly executed by said Minerals Separation American Syndicate (1913), Limited, bearing date October 11, 1916, which Power of Attorney was exhibited to me.

[SEAL.] EMMA L. BURKE,
Notary Public.

"A."

Patents Granted in Respect of the United States of America.

No.	763,259.	Classifier.
"	763,260.	Separator and Classifier.
"	763,749.	Separation of Minerals.
"	776,145.	Potter.
"	777,273.	Separator.
"	777,274.	Soap and Granulation.
"	784,999.	Separating and Concentrating.
"	788,247.	Soap and Flotation.
"	793,808.	Air Bubbles.

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No.	809,959.	Kirby Separator.
"	835,120.	Oleic Acid Froth.

No. 835,143. Boiling.
" 835,479. Super-Aerator.
" 838,626. Kirby Separator.
" 864,597. De Bavay.
" 879,985. Table Flotation.
" 902,018. Buddle.
" 912,783. De Bavay.
" 953,746. Froth Apparatus with Baffle.
" 955,012. Alcohol.
" 962,678. Solution.
" 979,857. Frothing Apparatus Agitator as Pump.
" 1,045,970. T. J. Greenway.
" 1,064,209. Staggered Spitz.
" 1,064,723. Essential Oils.
" 1,067,485. Fractional Flotation.
" 1,071,784. Controlling the Flow of thick, pulpy Material.
" 1,079,107. Sodium Bisulphate.
" 1,084,196. Open Spitz.
" 1,084,210. Agitator.
" 1,093,463. Froth Trap.
" 1,099,699. Copper Ores without Acid.
" 1,101,506. Bradford.
" 1,102,873. Doctored Water.
" 1,102,738. Bi-chromate.
" 1,102,874. Modifying during Grinding.
" 1,142,821. Alkali & Bi-chromate.
" 1,142,822. Littleford.
" 1,155,815. Sub-Aerator.

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No. 1,155,816. Sub-Aeration Apparatus.
" 1,155,836. Owen's Apparatus.
" 1,155,861. Bubble Separation without oil.
" 1,170,665. Acid Sludge.
" 1,170,637. Sulphuric Acid Compounds.
" 1,157,176. Owen's permanganate.

Applications.

Ser. No. 262,890. Air Flotation without Oil (abandoned).
" 766,346. Metallic Sulphides.
" 793,270. Steam Spray.
" 800,966. Ferric Chloride.
" 808,986. Copper Precipitant.
" 824,765. Alkaline Float.
" 831,939. Flotation Process by Sub-Aeration.
" 835,812. Owen's Selective Flotation.
" 843,304. Sodium Carbonate.
" 845,086. Copper Precipitant.
" 858,737. Insufficient Acid.
" 858,738. Insufficient Frothing Agent.

Ser. No. 863,097. Classifying.
" 863,098. Sizing.
" 864,230. Argol.
" 872,470. Aqueous Extracts of Oil.
" 14,015. Electrical Relations (1).
" 20,815. Hebbard's Coke.
" 27,098. Concentrated Alkali.
" 34,644. Electrical Relations (2).
" 37,350. Scale & Shellshear.
" 39,927. Metallic Sulphides.
" 40,847. Bleaching Powder.

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Ser. No. 766,346. Metallic Sulphides.
" 74,921. Martin's Inventions.
" 74,922. Martin's Inventions.
" 91,873. Horizontal Agitator.
" 94,339. Caustic Alkalis.
" 105,916.

Divisional from

Ser. No. 14,015
Ser. No. 108,208 } Electrical Relations (1).
" 108,209

Divisionals from

Ser. No. 766,346. Metallic Sulphides.

Divisional from

Ser. No. 824,765. Alkaline Float.

cv *Patents Granted in Respect of the Dominion of Canada.*

No. 76,621. Potter.
" 87,700. Air Bubbles.
" 88,785. Separator.
" 87,786. Classifier.
" 94,332. Di-electric Separator (Abandoned).
" 94,516. Soap.
" 94,718. Concentrating Table.
" 96,182. Oleic Acid Froth.
" 96,183. Air Flotation.
" 99,743. Super-Aerator.
" 121,676. Potter's S. O. T. Limited (Abandoned).
" 127,397. Solution.
" 129,819. Froth Apparatus with Baffle.
" 129,820. Agitator as Pump.
" 134,271. Essential Oils.
" 135,089. Livening Oxidised Ores.
" 137,404. Fractional Flotation.

No. 142,607. Copper Ores without Acid.
" 147,431. Sodium Bisulphate.
" 147,432. Agitator.
" 148,275. Froth Trap.
" 151,479. Open Spitz.
" 151,480. Bi-chromate.
" 151,619. Bradford.
" 151,810. Steam Spray.
" 157,488. Modifying during Grinding.
" 157,603. Metallic Sulphides.
" 157,604. Copper Percipitant.

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No. 160,692. Staggered Spitz.
" 160,693. Ferric Chloride.
" 160,694. Sub-Aerator.
" 160,846. Alkali & Bichromate.
" 160,847. Sodium Carbonate.
" 160,848. Insufficient Frothing Agent.
" 160,849. Insufficient Acid.
" 160,850. Alkaline Float.
" 163,608. Doctored Water.
" 163,707. Hebbard's Coke.
" 164,587. Bubble Separation without Oil.
" 165,390. Bleaching Powder.
" 163,936. Owen's Selective Flotation.
" 166,415. Electric Relations (1).
" 167,474. Sulphuric Acid Compounds.
" 167,603. Acid Sludge.
No. 167,475. Concentrated Alkali.
" 167,476. Scale & Shellshear.
" 160,937. Owen's Permanganate.
" 151,810. Steam Spray.
" 157,604. Copper Precipitant.
" 163,936. Owen's Selective Flotation.

Applications.

Ser. No. 202,962. Caustic Alkalis.
" " 204,309. Soap Froth.

cvii *Patents Granted in Respect to the Republic of Mexico.*

No. 3,276. Air Bubbles.
" 3,397. Separator & Classifier.
" 3,605. Potter.
" 3,642. Soap.
" 4,267. Amalgamation Agreement.
" 4,268. " "
" 4,269. " "

	No.	4,622.	Di-Electric Separator.
	"	4,635.	Concentrating Table.
Re-issue	"	4,907.	Oleic Acid Froth.
		5,561.	"
Re-issue	"	4,908.	Air Flotation.
	"	5,560.	"
	"	5,602.	Super-Aerator.
	"	5,603.	Cylinders & Selective Flotation.
	"	9,362.	Potter's S. O. T., Ltd.
	"	9,422.	Solution.
	"	9,502.	Froth Apparatus with Baffle.
	"	11,087.	Essential Oils.
	"	11,943.	Livening Oxidised Ores.
	"	11,989.	Frothing Apparatus Agitator as pump.
	"	12,050.	Copper Ores without Acid.
	"	12,200.	Froth Trap.
	"	12,201.	Fractional Flotation.
	"	12,781.	Potter's S. O. T., Ltd.
	"	13,316.	Sodium Bisulphate.
	"	13,749.	Howard's Agitator.
	"	13,820.	Doctored Water.
	"	13,991.	Staggered Spitz.

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	No.	14,196.	Bi-chromate.
	"	14,208.	Metallic Sulphides.
	"	14,344.	Open spitz.
	"	14,537.	Modifying during grinding.
	"	14,696.	Steam spray.
	"	14,749.	Ferric chloride.
	"	14,833.	Sub-Aerator.
	"	14,862.	Copper Precipitant.
	"	14,980.	Owen's Selective Flotation.
	"	15,030.	Alkaline Float.
	"	15,160.	Alkali and Bi-chromate.
	"	15,223.	Insufficient Acid.
	"	15,277.	Insufficient Frothing Agent.
	"	15,292.	Sodium Carbonate.
	"	15,513.	Bubble Separation without Oil.
	"	15,523.	Sulphuric Acid Compounds.
	"	15,524.	Acid Sludge.
	"	15,549.	his. Electrical Relations.
	"	15,598.	Hebbard's Coke.
	"	15,656.	Concentrated Alkali.
	"	15,618.	Bleaching Powder.
	"	15,625.	Scale & Shellshear.
	"	15,929.	Owen's Permanganate.
	"	14,537.	Modifying during Grinding.
	"	14,696.	Steam Spray.
	"	14,749.	Ferric Chloride.
	"	14,833.	Sub-Aerator.

No. 14,862. Copper Precipitant.
" 15,160. Alkali & Bi-chromate.

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No. 15,223. Insufficient Acid.
" 15,549, his. Electrical Relations (1).
" 15,656. Concentrated Alkalis.
" 16,003. Caustic Alkalis.

Patents Granted in Respect of the Republic of Cuba.

No. 1,520. Frothing Apparatus Agitator as Pump.
" 1,521. Alcohol & Solution.
" 1,946. Doctored Water.
" 1,976. Modifying during Grinding.
" 2,116. Copper Precipitant.

"B."

Various Licenses Granted.

Name of licensee.	Date of license.
Cuba Copper Co.	25th June, 1912.
Britannia Mining & Smelting Co.	19th November, 1912.
Silverton Mines	16th January, 1913.
Ducktown Sulphur Copper & Iron Co.	27th February, 1913.
Inspiration Copper Co.	10th April, 1913.
Colusa Parrot Mining & Smelting Co.	7th May, 1913.
Elm Orlu Mining Co.	7th May, 1913.
Wm. Macdonald & Louis S. Noble	13th May, 1913.
Atlas Mining & Milling Co.	22nd May, 1913.
Consolidated Arizona Smelting Co.	19th September, 1913.
Old Dominion Copper Mining & Smelting Co.	26th September, 1913.

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M. W. Atwater	6th February, 1914.
Flint Mines Ltd.	16 February, 1914.
Mountain Copper Co.	11th March, 1914.
Mond Nickel Co. Ltd.	30th April, 1914.
Mineral Recovery Co.	19th May, 1914.
Phelps Dodge & Co.	11th June, 1914.
Engels Copper Mining Co.	18th June, 1914.
Standard Silver Lead Mining Co.	24th June, 1914.
Cusi Mining Co.	22nd January, 1915.
Anaconda Copper Mining Co.	1st February, 1915.
Weedon Mining Co.	3rd June, 1915.
Arizona Copper Co. Limited (Registered in England)	11th June, 1915.
St. Joseph Lead Co.	16th August, 1915.

Name of licensee.	Date of license.
Doe Run Lead Co.	16th August, 1915.
Utah Leasing Co.	24th August, 1915.
Portland Gold Mining Co.	29th November, 1915.
Chichagoff Mining Co.	29th November, 1915.
Desloge Consolidated Lead Co.	1st January, 1916.
Sociedad Anonima des Metals Brockman & Co. Inc.	March, 1916.
Broadwater Mills Co.	14th March, 1916.
Arizona Copper Co. (Regd.) Clifton Greenlees Co. (Arizona)	21st March, 1916.
Greene Cananea Copper Co.	12th May, 1916.
Vindicator Consolidated Gold Mining Co.	26th June, 1916.
William Kent.	1st July, 1916.
Highland Valley Mining & Develop. Co. N. P. L.	10th August, 1916.
Ceylon Co.	15th August, 1916.

cxi EXHIBIT "C."

UNITED STATES OF AMERICA, ss:

[SEAL.]

The President of the United States of America to the Honorable the Judge of the District Court of the United States for the District of Montana, Greeting:

Whereas, lately in the United States Circuit Court of Appeals for the Ninth Circuit, in a cause between James M. Hyde, appellant, and Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, appellees, No. 2346, wherein the decree of the said Circuit Court of Appeals, entered in said cause on the 4th day of May, A. D. 1914, is in the following words, viz:

"This cause came on to be heard on the Transcript of the Record from the District Court of the United States for the District of Montana, and was duly submitted.

On consideration whereof, it is now here ordered, adjudged, and decreed by this Court, that the decree of the said District Court in this cause be, and hereby is, reversed, with costs in favor of the appellant and against the appellees, and that this cause be, and hereby is remanded to the said District Court with instruction to dismiss the bill.

cxii It is further ordered, adjudged, and decreed by this Court, that the appellant recover against the appellees for his costs herein expended, and have execution therefor."

as by the inspection of the transcript of the record of the said United States Circuit Court of Appeals which was brought into the Supreme Court of the United States by virtue of a writ of certiorari agreeably to the act of Congress, in such case made and provided, fully and at large appears.

And whereas, in the present term of October, in the year of our Lord one thousand nine hundred and sixteen, the said cause came on to be heard before the said Supreme Court, on the said transcript of record, and was argued by counsel:

On consideration whereof, It is now here ordered, adjudged, and decreed by this Court that the decree of the said United States Circuit Court of Appeals in this cause be, and the same is hereby, reversed with costs, and that the decree of the District Court of the United States for the District of Montana be, and the same is hereby, modified, as indicated in the opinion of this Court, and, as so modified, be, and the same is hereby, affirmed with costs; and that the said appellees, Minerals Separation, Limited, et al., recover against the said appellant One thousand nine hundred and eleven dollars and sixty-five cents for their costs herein expended and have execution therefor.

And it is further ordered that this cause be, and the same is hereby, remanded to the said District Court.

cxiii December 11, 1916.

You, therefore, are hereby commanded that such execution and proceedings be had in said cause, as according to right and justice, and the laws of the United States, ought to be had, the said writ of certiorari notwithstanding.

Witness, the Honorable Edward D. White, Chief Justice of the United States, the thirteenth day of January, in the year of our Lord one thousand nine hundred and seventeen.

JAMES D. MAHER,
Clerk of the Supreme Court of the United States.

Costs of Appellants.

Clerk	$676.40
Printing Record	$1,215.25
Attorney	20.00
	$1,911.65

Endorsement: File No. 24,396. Supreme Court of the United States, October Term, 1916. No. 46. Minerals Separation, Limited, et al. vs. James M. Hyde. Mandate. Filed March 5, 1917. Geo. W. Sproule, Clerk, by H. H. Walker, Deputy.

cxiv Supreme Court of the United States, October Term, 191–.

Costs of Minerals Separation, Limited, et al. in No. 46.

1914,	October Term—Docketing cause and filing record, $5.00; appearance, .25; filing precipe .25; filing papers, 1.75; filing briefs, $5.00; submission, .20; order, .20; issuing writ of certiorari $5.00; filing return .25, continuance .25	18.15
1915,	October Term—Transfer, $1.00; filing receipts .75; filing papers, 2.00; filing stipulation .25, continuance, .25	4.25
1916,	October Term—Transfer, $1.00; appearance, .25; filing precipe, .50; filing papers, 2.25; filing stipulation .25; filing briefs, $5.00; argument, .20; judgment, $1.00; filing same, .25; recording, .40; mandate, $5.00; preparing record for printer, etc., $637.50; cost of printing record, $1,215.25; attorney's docket fee, $20.00; costs and copy, .40	1,889.25
		1,911.65

Fee Book, page 24,396.

Test: JAMES D. MAHER,
Clerk of the Supreme Court of the United States.

cxv EXHIBIT "D."

$10.00 Recd. Mar. 28, 1917. H. C. C. U. S. Pat. Office.

United States Patent Office.

Hon. Commissioner of Patents.

SIR: Your Petitioner, Minerals Separation, Limited, a corporation organized and existing under the laws of Great Britain and having its principal place of business in London, England, hereby represents as follows:

1. That on November 6th, 1906, Letters Patent of the United States for Ore Concentration, No. 835,120, were granted to Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, of London, England, and your Petitioner is now the sole and exclusive owner of the said Letters Patent.

2. That by the decision of the Supreme Court of the United States in Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, vs. James M. Hyde, filed the 11th day of December, 1916, your Petitioner is advised that the said letters patent No. 835,120, in so far as concerns claims 9, 10 and 11 thereof, covers and includes more than the said inventors had a right to claim as new.

3. That the matter which the said patentees and your Petitioner are, in accordance with the said decision of the said court, not
cxvi entitled to hold or claim by virtue of said claims 9, 10 and 11 of said Letters Patent No. 835,120, was included therein by mistake, and without fraudulent or deceptive intent, and without any wilful default or intent to defraud or mislead the public.

4. That the subject-matter not herein and hereby disclaimed is definitely distinguishable from the part or parts disclaimed herein, and is truly and justly the invention of the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, and is a material and substantial part of the thing patented.

Your Petitioner, therefore, for the purpose of complying with the requirements of the law in such case made and provided, and of disclaiming those parts of the thing patented which your Petitioner does not choose to claim or hold by virtue of said Letters Patent No. 835,120, does hereby disclaim from claims 9, 10 and 11 of said letters patent No. 835,120, any process of concentrating powdered ores excepting where the results obtained are the results obtained by the use of oil in a quantity amounting to a fraction of one per cent on the ore.

In witness whereof your Petitioner has caused these presents to be signed and sealed by John Ballot, its duly constituted attorney in fact under and by virtue of a power of attorney dated December 14, 1915, and recorded in the United States Patent Office November 27, 1916, in Liber K 101, page 176 of Transfers of Patents, this 27th day of March, 1917.

MINERALS SEPARATION, LIMITED,
By JOHN BALLOT, [L. S.]
Attorney in Fact.

In presence of:
S. GREGORY.
HENRY D. WILLIAMS.

[On left margin:] Disclaimer recorded March 28, 1917.

cxvii STATE OF NEW YORK,
County of New York, ss:

On this 27th day of March, 1917, before me personally came John Ballot, attorney in fact of Minerals Separation Limited, a Company organized under the laws of Great Britain, to me personally known, and known to me to be the individual described in and who, as such attorney, executed the within petition and acknowledged that he executed the same as the act and deed of Minerals Separation, Limited, therein described, by virtue of a power of attorney duly executed by said Minerals Separation, Limited, bearing date December 14, 1915, which power of attorney was exhibited to me, and he stated that it was still in force and effect.

[SEAL.]

HARRY C. LEWIS,
Notary Public, Bronx Co. No. 12.

Certificate filed in New York County No. 41.

cxviii

EXHIBIT "E."

At a Stated Term of the United States District Court in and for the District of Montana, Held at the Court-rooms in the Federal Court Building, in the City of Butte, in said District, this 18th Day of April, 1917.

Present: Hon. George M. Bourquin, District Judge.

In Equity.

MINERALS SEPARATION, LIMITED, and MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, Complainants,

vs.

JAMES M. HYDE, Defendant.

This case having come on for final hearing on pleadings and proofs and having been argued by Henry D. Williams, Esq., in be-
cxix half of plaintiffs, and Walter A. Scott and Thomas F. Sheridan, Esqs., in behalf of defendant, and due consideration having been had, and plaintiff Minerals Separation, Limited, having filed a disclaimer of a part of the thing claimed in claims 9, 10 and 11 of the Letters Patent in suit, and having withdrawn said claims 9, 10 and 11 from this suit, and having waived an accounting of profits and damages, it is

Ordered, adjudged and decreed that the Letters Patent of the United States issued to Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, on November 6, 1906, No. 835,120 for improvements in Ore Concentration, are good and valid in law as to claims, 1, 2, 3, 5, 6, 7, and 12.

That the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot were the true, original, first and joint inventors of the invention described in the said Letters Patent and in the specification annexed thereto and particularly pointed out in claims 1, 2, 3, 5, 6, 7, and 12.

That Minerals Separation, Limited, one of the complainants herein, is the lawful, sole and exclusive owner of said Letters Patent, and that Minerals Separation American Syndicate, Limited, the other complainant, is the exclusive licensee under an agreement whereby both of the complainants must participate in the granting of licenses to use the said invention.

That James M. Hyde, the defendant herein, has infringed upon said Letters Patent, particularly as to claims 1, 2, 3, 5, 6, 7 and 12, and upon the exclusive rights of the complainants herein
cxx under the same by carrying on the process of ore concentration set forth and claimed in said Letters Patent as aforesaid.

That a perpetual injunction issue out of and under the seal of this court directed to the said defendant, James M. Hyde, enjoining and

restraining him, his confederates, associates, servants, agents, attorneys, clerks and workmen and every person acting for or in his behalf, from any installation or use in any manner of the said patented invention or any part thereof in violation of the rights of the complainants as aforesaid, and from encouraging and inducing others to infringe the said Letters Patent and from defending other infringers of said Letters Patent or reimbursing them for the expense of defending against said Letters Patent, in whole or in part, or otherwise aiding or abetting others to install or use processes of ore concentration in infringement of said Letters Patent.

April 18, 1917.

BOURQUIN, *J.*

Filed: May 1, 1917. Geo. W. Sproule, Clerk, by H. H. Walker, Deputy.

And thereafter, on May 4th, 1917, the defendant's answer to plaintiff's supplemental bill of complaint was filed, being as follows, to-wit:

cxxi In the District Court of the United States for the District of Montana.

In Equity.

No. 8.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN SYNDICATE, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Answer to Supplemental Bill of Complaint.

Comes now the above named defendant, and for answer to the supplemental bill of complaint, herein on file, admits, denies and alleges.

I.

cxxii Admits, that heretofore, to-wit: On or about the 10th day of October, 1913, the plaintiff, Minerals Separation, Limited, filed its bill of complaint in the above styled Court, alleging the issue and ownership of Letters Patent 835,120; and alleging infringement by the above named defendant; and alleging that there was a suit of the said plaintiff and another against James M. Hyde; and alleging in said bill of complaint that the said defendant participated therein; and alleging that by certain alleged conduct the

defendant became estopped; and praying for an injunction and accounting of profits and damages. Admits that defendant filed an Answer, an Amended Answer and a Supplemental Answer thereto.

II.

Answering the allegations contained in paragraph 2 of said Supplemental Bill of Complaint, defendant admits that the plaintiffs, Minerals Separation American Syndicate Limited and Minerals Separation North American Corporation, are corporations organized as alleged in said Supplemental Bill of Complaint.

III.

Answering the allegations contained in paragraph 3 of said supplemental Bill of Complaint, this answering defendant denies that it has any knowledge or information of the allegations therein contained sufficient to form a belief, and, therefore, the defendant requires proof of same; except that defendant specifically denies that there are any claims or demands or rights of action for profits and damages or for infringements of said Letters Patent, 835,120, by reason of the invalidity of said patent 835,120.

IV.

Answering the allegations contained in paragraph 4 of said Supplemental Bill of Complaint, this defendant admits the allegations therein contained; but in this connection, avers that the said finding and decision of said Supreme Court was directed to the said James M. Hyde, and was in no wise directed to this defendant, and in no wise affected this defendant, and that the legal rights of this defendant were not affected thereby.

V.

Answering the allegations contained in paragraph 5 of said Supplemental Bill of Complaint, defendant denies that on the 28th day of March, 1917, or at any other time, Minerals Separation, Limited, as the sole assignee of the patentee of said Letters Patent 835,120, for the whole of the United States or the territories and possessions thereof, or at all, in view of the aforesaid decision or mandate of the Supreme Court of the United States, or at all, or under or pursuant to the laws for such cases made and provided, or without unreasonable neglect or delay, entered its or any disclaimer of so much of the thing patented by claims 9, 10 or 11 of said Letters Patent 835,-120 as it did not choose to hold or claim by virtue of said Letters Patent. Denies that said Minerals Separation, Limited, filed a legal disclaimer, or a disclaimer which relinquishes or disclaims any part of said patent, or which disclaims or relinquishes claims 9, 10 or 11 of said patent. Admits that said plaintiff, Minerals Separation, Limited, filed in the Patent Office of the United States of America,

cxxiv that certain paper attached to plaintiff's Supplemental Bill of Complaint, marked "Exhibit D"; but denies that said paper is a disclaimer in law or in fact, or a disclaimer within the meaning of the laws of the United States.

VI.

Answering the allegations contained in paragraph 6 of said Supplemental Bill of Complaint, defendant admits that on the 16th day of April, 1917, the final decree was entered in said suit of Minerals Separation, Limited, and another against James M. Hyde, decreeing the validity of claims 1, 2, 3, 5, 6, 7, and 12 of said Letters Patent 835,120, and infringement thereof by the defendant in that case, James M. Hyde, and a perpetual injunction against the said defendant, James M. Hyde. Admits that the "Exhibit E," attached to said Supplemental Bill of Complaint is a copy of said decree. Admits that plaintiffs in that suit waived accounting against the said James M. Hyde; but deny that the said plaintiffs in that suit, or any plaintiff in this suit, filed proof of a disclaimer. Admits that the said plaintiffs in that suit did not ask for costs against the said James M. Hyde.

VII.

Answering the allegations contained in paragraph 7 of said Supplemental Bill of Complaint, defendant denies that the processes recited in claims 9, 10 or 11 of said Letters Patent 835,120, as limited by the alleged disclaimer, or as attempted to be limited thereby, were new or original inventions of the patentees thereof or that either or any of them was a new or original invention of the patentee thereof. Denies that said claims 9, 10 or 11 of said Letters
cxxv Patent 835,120, as limited by said alleged disclaimer, or as attempted to be limited by said alleged disclaimer, are good or valid. Denies that this defendant, subsequent to the issue of said Letters Patent 835,120, or prior to the filing of the Bill of Complaint herein, or at any other time, or at all, or without the license and allowance of the plaintiffs, or either or any of them, employed processes of concentrating powdered ores embodying or containing said alleged invention or inventions in infringement of said claims 9, 10 or 11 of said Letters Patent 835,120, as limited by said alleged disclaimer, or as attempted to be limited by said alleged disclaimer, or has employed processes of concentrating powdered ores embodying and containing the alleged invention or inventions of claims 1, 2, 3, 5, 6, 7 and 12, or any or either of them or at all of said Letters Patent, or continued or continues to do so, or has encouraged or has induced others to infringe or, otherwise, or at all. Denies each and every allegation in paragraph 7 of said Supplemental Bill of Complaint not hereinbefore specifically admitted or denied.

VIII.

This defendant states that paragraph 8 of said tendered Supplemental and Amended Bill of Complaint has, by notice of counsel, been embodied in the record as an amendment to the Bill of Complaint therein on file and denials of the allegations in said paragraph 8 are contained in the answer of defendant to the said complaint as amended, this day filed. This defendant denies each and every allegation contained in paragraph 8 of plaintiffs' Supplemental
cxxvi Bill of Complaint, except as admitted in said answer to the complaint as amended, to which reference is hereby made.

IX.

Answering the allegations contained in paragraph 9 of said Supplemental Bill of Complaint, defendant denies that the final decree entered on April 16th, 1917, in said suit of Minerals Separation, Limited, against James M. Hyde, is final or determinative against this defendant as to the issue of validity of claims 1, 2, 3, 5, 6, 7 and 12 of said Letters Patent 835,120, or as to any of said claims; or is final or determinative against this defendant at all. Denies that said final decree is final or determinative as to this defendant as to the issue of infringement of said claims by the acts or operations there complained of, or of any act or operation there complained of, or of any act or operation at all.

X.

Denies each and every allegation contained in said Supplemental Bill of Complaint not hereinbefore specifically admitted or denied.

Further answering said Supplemental Bill of Complaint, defendant alleges:

That after the determination of the case of Minerals Separation, Limited, and another, v. James M. Hyde, in the above styled court, the said case was considered by the Circuit Court of Appeals for the Ninth Circuit, on appeal from the above styled court, and that the said Circuit Court of Appeals in May, 1914, reversed and set
cxxvii aside the decree of the above styled court in favor of the Minerals Separation, Limited, and another, and against James M. Hyde, and did declare the said patent No. 835,120 and all of the claims thereof invalid and of no force or effect; that thereafter the said case of Minerals Separation, Limited, and another, vs. James M. Hyde reached the Supreme Court of the United States through a writ of certiorari and was thereafter argued before the said Supreme Court of the United States and a decision therein rendered by the Supreme Court of the United States, by which decision the decision and judgment of the Circuit Court of Appeals for the Ninth Circuit was reversed and set aside except that said Supreme Court of the United States did declare claims 9, 10 and 11 of said patent No. 835,120 invalid and of no force or effect, and that said decision so

declaring said claims invalid was rendered on the 11th day of December, 1916, and that said plaintiffs were, and each of them was, then and there on said date duly advised of the decision and order of the said Supreme Court of the United States upon the patent aforesaid and did know that the said Supreme Court of the United States had declared each and all of said claims 9, 10 and 11 invalid and that said plaintiffs have, and each of them has, wholly failed and unreasonably neglected and delayed the filing of a proper or any disclaimer in writing of the matters set forth in claims 9, 10 and 11 in the patent office of the United States of America except in this, that Minerals Separation, Limited, on March 28th, 1917, did file a paper purporting to be a disclaimer of 9, 10 and 11, which said paper was wholly and totally inadequate and was not in fact or in law
cxxviii a disclaimer of said claims 9, 10 or 11 in accordance with the decision and ruling of the Supreme Court of the United States; that said disclaimer was wholly insufficient in law or in fact to constitute a disclaimer at all; that said disclaimer was not filed until after a supplemental answer was filed in this case by the above named defendant setting up as a defense that the said then plaintiff in this case had wholly failed to file a disclaimer as shown by the pleadings and files in this case. Defendant attaches hereto a copy of said alleged disclaimer marked Exhibit "A." That the said Minerals Separation, Limited, one of the plaintiffs above named, was guilty of unreasonable neglect and delay in filing the said disclaimer and the said other plaintiffs herein have been guilty of unreasonable delay and neglect herein in filing the said disclaimer in writing; that by reason of the unreasonable neglect and delay of the said plaintiffs, and each of them, to disclaim in writing each and all claims to claims 9, 10 and 11, the whole of said patent No. 835,120 has become wholly void and invalid and of no force or effect, and that the plaintiffs cannot, nor can any of them, rely thereon, nor maintain action in equity under said patent and that the plaintiffs are, and each of them is, now barred by reason of the said unreasonable delay and neglect and failure of each of them from any relief of any kind or nature in equity, nor can plaintiffs, or either of them now be given any assistance in a court of equity for any alleged invasion of alleged rights under said patent, nor can plaintiffs, or either of them, maintain an action for injunction or accounting, and that plaintiffs are, and each of them is, estopped from any further pro-
cxxix ceedings herein by reason of the unreasonable neglect or delay to file a proper or any disclaimer to claims held invalid by the Supreme Court of the United States as aforesaid and in accordance with the statutes of the United States of America in such cases made and provided; that the said defendant further alleges that the said plaintiffs have and each of them has wholly failed up to this time to file a proper disclaimer in the Patent Office of the United States as required by law.

By way of further defense herein defendant alleges that the said plaintiffs are, and each of them is, estopped from asserting or claiming that its said alleged patent, or any claim thereof is infringed by the use of an amount of oil exceeding five-tenths of one per cent on the

weight of the ore treated at a given time, for the reason that the plaintiffs, Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, in a judicial proceeding, stated that the invention herein referred to was not practised by the use of an amount of oil in excess of five-tenths of one per cent on the weight of the ore treated and by the further statements in a judicial proceeding that the invention was not reached until the amount of oil reached and fell below five-tenths of one per cent on the ore treated and that each of said statements was made in a judicial proceeding in a court having jurisdiction of the subject matter; that the plaintiff, Minerals Separation North American Corporation, claims to be the successor in interest of the other plaintiffs herein; that by reason of said statements the said plaintiffs are, and each of them is, now precluded and estopped from asserting in this court of equity

cxxx that the invention embraces more than that described and claimed by it as aforesaid. Defendant alleges that said acts immediately last complained of did not occur until after the original joining of issue herein and the defendant did not become acquainted with the said facts until November, 1916.

Wherefore, defendant having fully answered plaintiffs' Supplemental Bill of Complaint, prays to be dismissed hence with its costs.

THOMAS F. SHERIDAN,
W. A. SCOTT,
J. BRUCE KREMER,
T. H. SHERIDAN,
L. P. SANDERS,
ALF. C. KREMER,
Solicitors for Defendant.

cxxxi UNITED STATES OF AMERICA,
District of Montana,
County of Silver Bow, ss:

J. L. Bruce, being first duly sworn, on oath deposes and says: That he is an officer, to-wit: the Manager and also the agent of the above-named defendant, and makes this verification in said capacity for and on behalf of the above named defendant; that he has read the foregoing answer to plaintiffs' supplemental complaint, knows the contents thereof, and that the matters and things therein stated are true to the best of his knowledge, information and belief.

J. L. BRUCE.

Subscribed and sworn to before me this 4th day of May, 1917.

C. H. TUOHY,
[NOTARIAL SEAL.] *Notary Public for the State of Montana,*
Residing at Butte, Montana.

My commission expires July 7th, 1918.

cxxxii

EXHIBIT A.

United States Patent Office.

Hon. Commissioner of Patents.

SIR: Your Petitioner, Minerals Separation, Limited, a corporation organized and existing under the laws of Great Britain and having its principal place of business in London, England, hereby represents as follows:

1. That on November 6th, 1906, Letters Patent of the United States for Ore Concentration, No. 835,120, were granted to Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, of London, England, and your Petitioner is now the sole and exclusive owner of the said Letters Patent.

2. That by the decision of the Supreme Court of the United States in Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, vs. James M. Hyde, filed the 11th day of December, 1916, your Petitioner is advised that the said Letters Patent No. 835,120, in so far as concerns claims 9, 10 and 11 thereof, covers and includes more than the said inventors had a right to claim as new.

3. That the matter which the said patentee and your Petitioner are, in accordance with the said decision of the said Court, not entitled to hold or claim by virtue of said claims 9, 10 and 11 of said Letters Patent No. 835,120, was included therein by
cxxxiii mistake, and without fraudulent or deceptive intent, and without any wilful default or intent to defraud or mislead the public.

4. That the subject-matter not herein and hereby disclaimed is definitely distinguishable from the part or parts disclaimed herein, and is truly and justly the invention of the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, and is a material and substantial part of the thing patented.

Your Petitioner, therefore, for the purpose of complying with the requirements of the law in such case made and provided, and of disclaiming those parts of the thing patented which your Petitioner does not choose to claim or hold by virtue of said Letters Patent No. 835,120 does hereby disclaim from claims 9, 10 and 11 of said Letters Patent No. 835,120, any process of concentrating powdered ores excepting where the results obtained are the results obtained by the use of oil in a quantity amounting to a fraction of one per cent on the ore.

In witness whereof your Petitioner has caused these presents to be signed and sealed by John Ballot, its duly constituted attorney in fact under and by virtue of a power of attorney dated December 14, 1915, and recorded in the United States Patent Office November

27, 1916, in Liber K 101, page 176 of Transfers of Patents, this 27th day of March, 1917.

MINERALS SEPARATION LIMITED,
By JOHN BALLOT, *Attorney in Fact.* [L. S.]

In presence of:
S. GREGORY.
HENRY D. WILLIAMS.

cxxxiv STATE OF NEW YORK,
County of New York, ss:

On this 27th day of March, 1917, before me personally came John Ballot, attorney in fact of Minerals Separation Limited, a Company organized under the laws of Great Britain, to me personally known, and known to me to be the individual described in and who, as such attorney, executed the within petition and acknowledged that he executed the same as the act and deed of Minerals Separation, Limited, therein described, by virtue of a power of attorney duly executed by said Minerals Separation, Limited, bearing date December 14, 1915, which power of attorney was exhibited to me, and he stated that it was still in force and effect.

[SEAL.] HARRY C. LEWIS,
Notary Public, Bronx Co. No. 12.

Certificate filed in New York County No. 48.

Filed May 4, 1917. Geo. W. Sproule, Clerk, by H. H. Walker, Deputy.

Service of the foregoing answer to supplemental bill of complaint accepted, and copies thereof received this 4th day of May, 1917.

O. W. McCONNELL,
HENRY D. WILLIAMS,
WM. HOUSTON KENYON,
Solicitors for Plaintiffs and of Counsel.

cxxxv And thereafter on May 4th, 1917, defendant's answer to plaintiffs' bill of complaint as amended was filed, being as follows, to-wit:

In the District Court of the United States for the District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN Syndicate, Limited, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Answer to Plaintiffs' Bill of Complaint as Amended.

The answer of Butte and Superior Mining Company, defendant, formerly Butte and Superior Copper Company, Limited,
cxxxvi to the bill of complaint of plaintiffs as amended.

The defendant now and at all times saving and reserving unto itself all and all manner of benefit and advantage of exception which can or may be had or taken to the errors, uncertainties or other imperfections contained in the bill of complaint as amended herein, for answer hereto, or to so much or such parts thereof as it is advised it is material to make answer unto, says as follows:

I.

Admits that the plaintiffs, Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, are corporations organized and existing under and by virtue of the laws of Great Britain; admits that the plaintiff, Minerals Separation North American Corporation is a corporation organized under the laws of the State of Maryland. Admits that the defendant is a corporation duly organized and existing under the laws of the State of Arizona and has a regular established place of business in the City of Butte, County of Silver Bow, State of Montana. Denies that it has committed acts, or any act, of infringement at said place, or at any other place, or at any time, or at all, as alleged in plaintiffs' bill of complaint as amended, or otherwise.

II.

Admits that this suit is brought under the patent laws of the United States for the alleged infringement of the United States
Letters Patent No. 835,120, issued November 6th, 1906,
cxxxvii for alleged improvements in ore concentration; but denies that there has been any infringement thereof by this defendant.

III.

Denies that on the 29th day of May, 1905, or at any other time, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard, and John Ballot were within the meaning of the statutes of the United States then in force, the original or first or joint inventors, or that either of them was, or that any of them were, the original or joint inventors of a certain new or useful process of ore concentration, or were entitled to patent thereon under the provisions of said statutes, or that they duly filed in the United States Patent Office an application for Letters Patent of said alleged invention; denies that on the 6th day of November, 1906, all of the requirements of the statutes having been duly complied with, the said Letters Patent of the United States No. 835,120 were duly issued on said application to the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, or either, or any of them; admits that a certain alleged patent being No. 835,120 was issued to Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot.

Denies each and every allegation contained in paragraph 3 of plaintiffs' bill of complaint as amended not hereinbefore specifically admitted or denied.

IV.

Denies that it has any knowledge or information as to whether on or about the 7th day of December, 1909, the said Henry
cxxxviii Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot duly or at all assigned to the plaintiffs, or any other person or corporation, all right, title and interest in and to said alleged invention and alleged Letters Patent, or that plaintiffs are now the sole owners of said alleged invention or Letters Patent, or of all rights of action, or claim, or demand for alleged infringement thereof since said alleged assignment.

V.

Defendant denies that said alleged invention is of great value or utility; denies that there was or is any invention in the said alleged patent No. 835,120; denies that it has any knowledge or information as to whether the plaintiffs have, or any, or either of them has been to great trouble or expense in demonstrating the alleged utility thereof, or in introducing the same into extensive commercial use in the United States, or elsewhere; denies that it has any knowledge or information as to whether the plaintiffs have, or any, or either of them has granted numerous licenses for carrying on said alleged process of ore concentration in the United States or elsewhere; denies that said alleged process has been or is now being extensively carried on in the United States, or elsewhere; denies that plaintiffs have, or any, or either of them has any patent upon any alleged process, and denies that plaintiffs have, or any, or either of them has,

the right to grant licenses for the use of said alleged process conditioned on the payment of royalty measured by the output
cxxxix of said alleged process of ore concentration, or otherwise, or at all.

Denies each and every allegation contained in paragraph 5 of plaintiffs' bill of complaint as amended not hereinbefore specifically admitted or denied.

VI.

Answering the allegations contained in paragraph 6 of plaintiffs' bill of complaint as amended, this defendant denies that it has infringed or is infringing the said alleged Letters Patent since the plaintiffs, or any, or either of them, acquired the same, or at any other time, or at all, by installing apparatus for or carrying on the use of said alleged process of ore concentration, or in any other manner, or at all, at the town of Basin, in the County of Jefferson, State of Montana, or at the City of Butte, Silver Bow County, State of Montana, or at any other place, or at all, without the consent or allowance of the plaintiffs, or any, or either of them, or at all; denies that said alleged process of ore concentration alleged to have been carried on by this defendant embodied the said alleged invention as claimed in claims one (1), or two (2), or three (3), or five (5), or six (6), or seven (7), or nine (9), or ten (10), or eleven (11), or twelve (12), or any other claim of said alleged Letters Patent; denies that the defendant is carrying on any alleged infringement at the last named place, or at any other place, or at all, as a continuing or any act or threatens to continue to use said process, or to infringe or threatens to infringe at all; denies that defendant has ever infringed said alleged patent.

cxl VII.

Answering the allegations contained in paragraph 7 of plaintiffs' bill of complaint as amended, defendant admits that the plaintiff, Minerals Separation, Limited, and another, on or about the 9th day of October, 1911, brought suit in this court against James M. Hyde for alleged infringement of Letters Patent No. 835,120, but denies that said suit was fully contested on its merits, but admits that said suit was presented at length to this court on briefs and arguments of counsel, and that this court, in an opinion filed July 26th, 1913, the court having jurisdiction of the persons and subject matter in said suit, directed that an interlocutory decree be entered adjudging the validity of said Letters Patent as against James M. Hyde, and infringement thereof by said James M. Hyde as to the particular claims charged to be the subject matter of the alleged infringement by the defendant herein; but denies that there was an adjudication of the validity of said Letters Patent as against this defendant, or any of claims of said Patent as against this defendant, or that this defendant was in any manner affected by or was in any manner a party to the said alleged suit above referred to; admits that the above styled court directed the issuance of an injunction restraining from alleged fur-

ther infringement by the said James M. Hyde and a reference to a master for ascertaining profits and damages to be awarded against the said James M. Hyde, and admits that on the 15th day of August, 1913, a decree was entered as directed by the said court, and that thereafter a permanent injunction restraining the said James
exli M. Hyde from further alleged infringement of said Letters Patent No. 835,120 was issued by the above court. Further answering this defendant alleges that thereafter said cause was duly and regularly appealed to the Circuit Court of Appeals and was thereafter presented before the Supreme Court of the United States, it having reached the said court on writ of certiorari as more fully and particularly appears from the pleadings and records herein on file. Further answering the allegations contained in paragraph 7, this defendant denies each and every allegation contained therein not hereinbefore specifically admitted or denied.

VIII.

Answering the allegations contained in paragraph 8 of plaintiffs' bill of complaint as amended, this defendant denies that at the time referred to in said paragraph 8, or any other time, or at all, the defendant, Butte and Superior Mining Company, invited said James M. Hyde to test the applicability of flotation to the ores of the Butte and Superior Mining Company; denies that thereafter, Butte and Superior Mining Company investigated through its own attorney or counsel the matter of infringement of alleged Letters Patent of Minerals Separation, Limited, by such application, or at all, save and except insofar as an investigation was made necessary through proceedings taken against said Butte and Superior Mining Company, or threats of proceedings against said Butte and Superior Mining Company, of which threats this pending suit is the outcome; ad-
exlii mits that the said defendant entered into an agreement with the said James M. Hyde whereby Hyde, as an independent engineering contractor, was to do certain work in connection with the application of flotation to the ores of Butte and Superior Mining Company, and was to superintend under said independent contract the erection and operation of a plant as provided in the contract made and entered into with the said James M. Hyde by the said Butte and Superior Copper Company, Limited, now Butte and Superior Mining Company, but not otherwise. This defendant annexes hereto and makes a part hereof a copy, of said contract made and entered into between the said James M. Hyde and Butte and Superior Copper Company, Limited, the same being marked Exhibit "A"; admits that by the terms of said contract the said James M. Hyde was to be paid such expenses as are provided in said contract and not otherwise, and was to have additional payment as provided for in said contract and not otherwise; denies that it was further agreed between the said Butte and Superior Copper Company, Limited, and said James M. Hyde that said Butte and Superior Copper Company, Limited, would defend said Hyde or hold him harmless in case he should be sued by Minerals Separation, Limited, or any other person or cor-

poration, or at all, for infringement by reason of the erection and operation of said plant for said Butte and Superior Mining Company, or otherwise; denies that the acts, or any act, of said Hyde complained of in said suit of Minerals Separation, Limited, and another
exliii against James M. Hyde, or any other suit, as the acts of infringement, there or at all consisted in the operation of the plant, or any plant, erected or operated by said Hyde for the Butte and Superior Mining Company, but in this connection this defendant avers that said plant was erected by the said Hyde as an independent contractor and not as an employee of the Butte and Superior Mining Company and was erected as set forth in said agreement, and this defendant admits that it was in said plant referred to in said agreement that the said Hyde committed the acts which plaintiffs claim were acts of infringement, but defendant avers that it had no control over the acts of said James M. Hyde, he acting under the provisions of said independent contract hereto annexed. This defendant denies that it directed the said operation; denies that said alleged acts of infringement by the said Hyde were conducted in the mill of the said Butte and Superior Mining Company with apparatus or ingredients belonging to said Company, except as herein stated, to-wit: under the independent contract existing between the said Hyde and the said Company; admits that said alleged operations were conducted upon the ore of said Company, but denies that the same were for the benefit or advantage of said Company, save and except as set forth in said contract, a copy of which is hereto annexed and marked Exhibit "A"; denies that said alleged acts of infringement by the said Hyde were conducted by the employes of Butte and Superior Mining Company under the superintendence of the said
exliv Hyde, but in this connection avers that the said Hyde conducted the alleged acts herein referred to, save and except where manual labor was concerned and that in this connection defendant admits that men engaged in and about the plant of said Butte and Superior Mining Company by said Company performed manual labor in and about said plant; denies that in those operations, or in any operation, or at all, the said Hyde was an employe of the said Company; denies specifically that the said Hyde was ever an employee of the said Company; denies specifically that said Butte and Superior Mining Company conducted or controlled the defense from the beginning to the end of said suit of Minerals Separation, Limited, and another v. James M. Hyde; denies specifically that the said Butte and Superior Mining Company at any time, or at all, conducted or controlled the defense of the said suit of Minerals Separation, Limited, and another v. James M. Hyde; denies specifically that said Butte and Superior Mining Company at any time had conduct or control of the defense of said suit, or that the Butte and Superior Mining Company at any time ever had any authority to direct the said litigation or to withdraw the defense of the same or to dispose of the same by settlement, or otherwise, or at all, or ever had any conduct or control of said litigation; denies that the said Butte and Superior Mining Company paid all the expenses of said suit or paid the said James M. Hyde for his expenses in assisting in the defense of

said suit, except as follows, to-wit: that the said Butte and Superior Mining Company purchased of and from the said James M.
cxlv Hyde the exclusive rights and privileges in the County of Silver Bow, State of Montana, for the treatment of ores produced therein by all processes or patents which the said James M. Hyde might have or procure in connection with the flotation or treatment of ores or metals, and that the said Company agreed to pay for said exclusive license aforesaid all the expenses of the said suit of Minerals Separation, Limited, v. James M. Hyde for the said Hyde. This defendant avers that the said expenses of said litigation were paid for the said Hyde as a consideration as aforesaid and not otherwise; admits that the said James M. Hyde applied for and obtained a patent No. 1,022,085 for the concentration of ores in the re-treatment of concentrates and other features involved in the operation of the mill of Butte and Superior Mining Company, and involved in the operations of any and every other mill using any character of flotation process; denies that said patent was embraced in the said alleged charge of act of infringement against the said Hyde; denies that said patent was granted or issued for what was not the invention of said Hyde or any invention over the art, and denies specifically that said application for said patent was an afterthought, or a sham, or device to aid in the defense of said suit, but avers that said patent is a valuable patent recognized and existing and rendering efficient and great benefit to the art of flotation; denies that long subsequently, or after the suit was argued at final hearing in this court the said Hyde granted to Butte and Superior Mining Company an exclusive
cxlvi license under said patent for the County of Silver Bow, State of Montana, but admits that said Hyde did grant an exclusive license under said patent to the Butte and Superior Mining Company for the County of Silver Bow, State of Montana, and for all ore produced therein, said Hyde having agreed to grant said exclusive license aforesaid long prior to the application for patent No. 1,022,085 for the consideration as herein alleged to have been paid by the Butte and Superior Mining Company to the said Hyde, and not otherwise; denies that said license was granted for and in consideration of said Company paying all, or any, of the expenses of the defense of said suit of Minerals Separation, Limited, v. James M. Hyde except as herein set forth or holding said Hyde harmless therein; denies that said Company ever agreed to hold said Hyde harmless therein; denies that said Company ever made any agreement for the defense of said suit save and except as herein set forth, to-wit: that said Company paid to the said James M. Hyde as a consideration for the license aforesaid an amount sufficient to pay the costs of the defense of said suit; denies that said license was without value or that said consideration was paid for nothing, or that the transaction was an afterthought, or a sham, or a device to avoid the legal or any effect of the actual or any relationship of Butte and Superior Mining Company to the defense of said suit; denies that said Butte and Superior Mining Company had any actual relationship to the defense of said suit; denies that the Butte and Superior Mining Company

exlvii had anything whatsoever to do with the defense of said suit as herein set forth; denies specifically that the Butte and Superior Mining Company ever had the direction of the defense of said suit or the control of said suit, or the control or direction of said litigation at any time, or at all, or could have withdrawn the said defense, or could have settled the said action, or could have disposed of the same, or any part thereof, in any manner, or at all; denies that the process introduced by the said Hyde into the Butte and Superior Mining Company's plant was continued in use by the said Company, except in part by or through other employees or other superintendence or in other plants. In this connection this defendant avers that the said process was from time to time modified and changed; denies that to the extent that the said Hyde was concerned in the operations decreed in said Hyde suit to be an infringer of said Letters Patent No. 835,120, or to any extent, or at all, this defendant was the master, or the principal, or was the joint tort feasor with the said Hyde; denies specifically that this defendant was at any time, or at all, the master, of the said Hyde, or the principal of the said Hyde, or was a joint tort feasor with the said Hyde; denies specifically that this defendant conducted the defense of the said Hyde in said suit against the said Hyde for its own protection or with the knowledge of the plaintiffs, or has had its day in court; denies that the said defendant conducted the defense of the said Hyde in said suit at all; denies that the said plaintiffs, or any, or either of them, ever at any

exlviii time had any knowledge whatsoever that the said defendant conducted said suit; denies that there was any knowledge of said fact to be had by any person, or at all; denies specifically the said allegation that the said defendant conducted the said suit and denies specifically the allegation that the said plaintiffs had any knowledge of the existence of a fact which did not exist; denies specifically that said defendant has had its day in court insofar as concerns the issues there raised or determined; denies that this defendant is bound by the said final decree, or any decree, against the said James M. Hyde in said case on April 16th, 1917, or any decree to the extent that the said Letters Patent in suit No. 835,120, are valid as against claims numbers one, two, three, five, six, seven or twelve, or any other claims, or at all, and specifically denies that this defendant is bound by the said decree in the Hyde case in any manner, or at all, as to any claims, or at all, and specifically denies that the said defendant is bound by said decree to the extent that said decree provides that said claims aforesaid were infringed by the acts or operations there complained of, and specifically denies that this defendant is bound by any decree in said Hyde suit, or is bound at all by said decree in said Hyde suit.

Denies each and every allegation contained in paragraph eight of plaintiffs' bill of complaint as amended not hereinbefore specifically admitted or denied.

IX.

Answering the allegations contained in paragraph 9, this

exlix defendant admits that prior to the commencement of said suit against James M. Hyde, the plaintiffs made claims to the

defendant in this suit that they claimed certain rights under said Letters Patent No. 835,120, but this defendant denies that the plaintiffs or any of them in fact had any rights under said Letters Patent No. 835,120. This defendant admits that it was advised of the proceedings in the said suit of Minerals Separation, Limited, and another, against James M. Hyde; admits that the above styled court in said action issued a permanent injunction in pursuance of said decree against the said James M. Hyde; admits that the said injunction and decree was directed to the said James M. Hyde, his confederates and associates, but denies that this defendant was at any time or is now a confederate or associate with the said James M. Hyde, and denies that it was in anywise or at all, bound or affected by said decree or said injunction; admits that a copy of said decree was served upon this defendant; denies that this defendant has ever infringed the said Letters Patent or has continued to infringe the said Letters Patent in defiance of the decree of this court or of the injunction issued thereon, to its own profit or to the damage of the plaintiffs or any of them or has at any time, or at all, infringed the said Letters Patent; denies that there was ever a decree of this court or an injunction of this court issued which in any manner affected the above-named defendant in the use of a flotation process, or otherwise, or at all.

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X.

Denies each and every allegation contained in plaintiffs' bill of complaint as amended not hereinbefore specifically admitted or denied.

Further answering plaintiffs' bill of complaint as amended, defendant says:

I.

(*a*) That the supposed invention set forth in said Letters Patent, No. 835,120, had been patented and had been described in printed publications prior to the supposed invention thereof by said Sulman, Kirkpatrick-Picard and Ballot, and had been patented and described in printed publications more than two years prior to their application for a patent therefor; that said supposed invention was patented and fully described in each of the following described patents and publications, each of which patents was granted and became a patent and each of which patents and publications was published as a printed publication more than two years prior to the application by said Sulman, Picard and Ballot for said patent No. 835,120:

British patent to William Haynes, No. 488, dated February 23, 1860, sealed August 17, 1860.

United States Patents.

No.	Date of patent.	Patentee.
348,157	Aug. 24, 1886	C. J. Everson.
575,669	Jan. 19, 1897	G. Robson.
469,599	Feb. 23, 1892	A. M. Rouse.

cli Publications.

The Daily Herald Democrat, published at Leadville, Colorado, October 30, 1889.

The Engineering and Mining Journal, published at New York City, N. Y., November 15, 1890.

(*b*) That said supposed invention was patented and fully described in each of the patents and publications set forth in paragraph (*a*) hereof and in the following described patents and publications, each of which patents was granted and became a patent, and each of which patents and publications was published as a printed publication prior to the supposed invention thereof by said Sulman, Kirkpatrick-Picard and Ballot.

No.	Date of patents.	Patentee.
736,381	Aug. 18, 1903	M. F. R. Glogner.
745,960	Dec. 1, 1903	I. F. Good.
763,259	June 21, 1904	A. E. Cattermole.
763,260	June 21, 1904	A. E. Cattermole.
763,749	June 26, 1904	G. A. Goyder and E. Laughton.
768,035	Aug. 23, 1904	G. D. Delprat.
777,273	Dec. 13, 1904	A. E. Cattermole.
777,274	Dec. 13, 1904	A. E. Cattermole, H. L. Sulman and H. F. Kirkpatrick-Picard.
784,999	Mar. 14, 1905	G. A. Goyder and E. Laughton.
776,145	Nov. 29, 1904	C. V. Potter.
787,814	Apr. 18, 1905	J. D. Wolf.
788,247	Apr. 25, 1905	H. L. Sulman, H. F. Kirkpatrick-Picard and A. E. Cattermole.

clii British patent to Henry Harris Lake, communicated by Alcide Froment, No. 12,778 of 1902, applied for June 4, 1902, complete specification left March 4, 1903, accepted June 4, 1903, sealed August 18, 1903.

Italian patent to Alcide Froment, Regro Genle Vole 43, No. 63,723. Regro Attes. Vol. 156, No. 166, May 20, 1902.

Publications.

The California Journal of Technology for November, 1903, published at Berkeley, California, by the students in the Applied Science Colleges in the University of California, which con-

tains upon pages 34 to 41 an article by W. F. Copeland, Drury Butler and James H. Wise, entitled "Experiments on the Elmore Process of Oil Concentration."

(*c*) That said Sulman, Kirkpatrick-Picard and Ballot were not the original or first inventors or discoverers of any material or substantial part of the thing patented in and by said patent No. 835,120, but that said supposed invention and all material and substantial parts thereof had before their alleged invention thereof been invented by the several persons named and referred to in paragraphs (*a*) and (*b*) hereof, and by them patented and described as therein set forth, and by others who fully and clearly described every material and substantial part of said supposed invention in applications filed by them in the United States Patent Office for United States patents and in Letters Patent granted by the United States, and that the following are the names of said parties, the dates of the patents granted them, and the date of filing of the United States patent ap-
cliii plications in those instances where the patents were granted subsequent to the date of alleged invention by Sulman, Kirkpatrick-Picard and Ballot:

United States Patents.

No.	Date of patent.	Patentee.
228,004	May 25, 1880	J. Tunbridge.
345,951	July 20, 1886	H. Bradford.
373,113	Nov. 15, 1887	Henry J. Wagner.
444,345	Jan. 6, 1891	E. R. Gabbett.
466,753	Jan. 5, 1892	E. A. Hockley.
469,599	Feb. 23, 1892	A. M. Rouse.
471,174	Mar. 22, 1892	C. B. Hebron & C. J. Everson.
474,829	May 17, 1892	C. B. Hebron.
521,899	June 26, 1894	Joseph Wm. Sutton.
653,340	July 10, 1900	F. E. Elmore.
637,222	Feb. 5, 1901	John W. Ivery.
676,679	June 18, 1901	F. E. Elmore.
689,070	Dec. 17, 1901	A. S. Elmore.
692,643	Feb. 4, 1902	A. S. Elmore.
703,905	July 1, 1902	A. S. Elmore.
729,805	June 2, 1903	J. & L. Stoveken.
735,071	Aug. 4, 1903	G. D. Delprat.
763,259	June 21, 1904	A. E. Cattermole.
763,859	June 28, 1904	J. D. Darling.
768,035	Aug. 23, 1904	G. D. Delprat.
770,659	Sept. 20, 1904	J. B. Scammell.
776,145	Nov. 29, 1904	C. V. Potter.

cliv

No.	Date of patent.	Date of application.	Patentee.
787,814	Apr. 18, 1905	May 22, 1903	J. D. Wolf of London, England.
788,247	Apr. 25, 1905	Mar. 29, 1904	A. E. Cattermole, H. L. Sulman and H. F. Kirkpatrick-Picard of London, England.
793,808	July 4, 1905	Oct. 5, 1903	H. L. Sulman and H. F. Kirkpatrick-Picard of London, England.
807,502	Dec. 19, 1905	May 27, 1904	A. Schwarz of New York, N. Y.
807,503	Dec. 19, 1905	May 27, 1904	A. Schwarz of New York, N. Y.
807,504	Dec. 19, 1905	Sept. 21, 1904	A. Schwarz of New York, N. Y.
807,505	Dec. 19, 1905	Oct. 14, 1904	A. Schwarz of New York, N. Y.
807,506	Dec. 19, 1905	Nov. 4, 1904	A. Schwarz of New York, N. Y.
809,959	Jan. 16, 1906	Dec. 14, 1903	Edmund B. Kirby, formerly of Rossland, British Columbia, now of St. Louis, Mo.
838,626	Dec. 18, 1906	Dec. 17, 1903	Edmund B. Kirby, formerly of Rossland, British Columbia, now of St. Louis, Mo.

(*d*) That said H. L. Sulman, H. F. Kirkpatrick-Picard and John Ballot unjustly obtained said patent No. 835,120 for that which was in fact invented by others who were using reasonable diligence in adapting and perfecting the same; that said other parties filed in the United States Patent Office applications for patents fully describing the supposed invention set forth in said patent No. 835,120 and obtained patents therefor; the names of said other parties, the

clv dates when they filed said patent applications, the numbers of the patents so granted, and the dates when said patents were granted being as follows:

No.	Date of patent.	Date of application.	Patentee.
787,814	Apr. 18, 1905	May 22, 1903	J. D. Wolf of London, England.
788,247	Apr. 25, 1905	Mar. 29, 1904	A. E. Cattermole, H. L. Sulman and H. F. Kirkpatrick-Picard, all of London, England.
793,808	July 4, 1905	Oct. 5, 1903	H. L. Sulman and H. F. Kirkpatrick-Picard, of London, England.
807,502	Dec. 19, 1905	May 27, 1904	A. Schwarz, New York, N. Y.
807,503	Dec. 19, 1905	May 27, 1905	A. Schwarz, New York, N. Y.
807,504	Dec. 19, 1905	Sept. 21, 1904	A. Schwarz, New York, N. Y.
807,505	Dec. 19, 1905	Oct. 14, 1904	A. Schwarz, New York, N. Y.
807,506	Dec. 19, 1905	Nov. 4, 1904	A. Schwarz, New York, N. Y.
809,959	Jan. 18, 1906	Dec. 14, 1903	Edmund B. Kirby, formerly of Rossland, British Columbia, now of St. Louis, Mo.
838,626	Dec. 18, 1906	Dec. 17, 1903	Edmund B. Kirby, formerly of Rossland, British Columbia, now of St. Louis, Mo.

clvi II.

Also prior to the supposed invention or discovery of the alleged process patented in said Letters Patent No. 835,120 by said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot each and every material and substantial part of said supposed invention or discovery so patented had been invented and used by and was known to the following named persons, and was fully described in applications for Letters Patent of the United States deposited and filed by said persons in the United States Patent Office prior to the supposed invention or discovery of said alleged process set forth in said Letters Patent No. 835,120 by said Sulman, Kirkpatrick-Picard and Ballot; that said applications were so deposited and filed in the United States Patent Office and that Letters Patent of the United States were granted upon said applications as set forth below:

Moritz F. R. Glogner, a resident of Freiburg, in the Kingdom of Prussia, German Empire, on January 27, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 736,381 were granted thereon upon Aug. 18, 1903.

Israel F. Good, a resident of Allentown, Pennsylvania, on October 1, 1902, deposited and filed in the United States Patent Office, his application for Letters Patent of the United States, and that Letters Patent No. 745,960 were granted thereon upon December 1, 1903.

clvii Guillaume D. Delprat, a resident of Broken Hill, Australia, on January 2, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 768,035 were granted thereon upon August 23, 1904.

Cosmo Kendall, a resident of Upper Norwood, Surrey, England, on July 21, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 771,975 were granted thereon upon September 27, 1904.

Charles V. Potter, a resident of Balaclava, Victoria, Australia, on January 14, 1902, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 776,145 were granted thereon upon November 29, 1904.

Arthur E. Cattermole, a resident of Highgate, London, England, on September 28, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 777,273 were granted thereon upon Dec. 13, 1904.

Arthur E. Cattermole, Henry Sulman and Hugh F. Kirkpatrick-Picard, all residents of London, England, on March 29, 1904, deposited and filed in the United States Patent Office their application for Letters Patent of the United States, and that Letters Patent No. 777,274 were granted thereon upon December 13, 1904.

clviii Arthur E. Cattermole, Henry L. Sulman and Hugh F. Kirkpatrick-Picard, all residents of London, England, on March 29, 1904, deposited and filed in the United States Patent Office their application for Letters Patent of the United States, and that Letters Patent No. 788,247 were granted thereon upon April 25, 1905.

Henry L. Sulman and Hugh F. Kirkpatrick-Picard, residents of London, England, on October 5, 1903, deposited and filed in the United States Patent Office their application for Letters Patent of the United States, and that Letters Patent No. 793,808 were granted thereon upon July 4, 1905.

Alfred Schwarz, a resident of New York City, New York, on April 19, 1905, deposited and filed in the United States Patent Office, his application for Letters Patent of the United States, and that Letters Patent No. 807,501 were granted thereon upon December 19, 1905.

Alfred Schwarz, a resident of New York City, New York, on May 27, 1904, deposited and filed in the United States Patent Office, his application for Letters Patent of the United States, and that Letters Patent No. 807,503 were granted thereon upon December 19, 1903.

Edmund B. Kirby, a resident of Rossland, Canada, on December 14, 1903, deposited and filed in the United States Patent Office his

application for Letters Patent of the United States, and that Letters Patent No. 809,959 were granted thereon upon January 16, 1906.

clix Edmund B. Kirby, a resident of Rossland, Canada, on December 17, 1903, deposited and filed in the United States Patent Office his application for Letters Patent of the United States, and that Letters Patent No. 838,626 were granted thereon upon December 18, 1906.

Also patented or described and contained in other Letters Patent, the dates, numbers, and grantees of which this defendant is not now able to specify, but prays to be allowed hereafter to add by amendment of this answer or otherwise, if it shall become necessary.

Also illustrated and described in printed publications, the names and dates — which defendant is not able to specify, but prays to be allowed hereafter to add to this answer by amendment or otherwise, if it shall become necessary.

III.

This defendant avers that for the purpose of deceiving the public the description and specification filed by the said patentees in the Patent Office was in some particulars made to contain more than the whole truth relative to their alleged invention or discovery and more than is necessary to produce the desired effect, and that in other particulars the said description and specification was made to contain less than the whole truth relative to their alleged invention or discovery.

IV.

This defendant says that the said patentees, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot,

clx and said plaintiffs herein, Minerals Separation, Limited, have admitted that the alleged invention which said Letters Patent No. 835,120 purport to embrace, and each and every material and substantial part thereof, was old and known to others prior to their alleged invention and discovery thereof, and have stated that said alleged invention was the invention of others, and that said patentees made such admissions and statements in the following described Letters Patent, and in the applications therefor and proceedings in the United States Patent Office relating thereto, and also in other patents, documents and writings.

Letters Patent of the United States.

793,808 Sulman & Kirkpatrick-Picard, application filed October 5, 1903, patented July 4, 1905.

835,143 Henry L. Sulman, application filed October 20, 1905, patentered November 6, 1906.

835,479 Sulman, Kirkpatrick-Picard & Ballot, application filed May 20, 1905, patented November 6, 1906.

879,985 Sulman, Kirkpatrick-Picard & Ballot, application filed February 20, 1905, patented February 25, 1908.

Letters Patent of Great Britain.

17,109 August 6, 1903, Cattermole, Sulman & Kirkpatrick-Picard.
20,419 September 22, 1903, Sulman and Kirkpatrick-Picard.
5,260 March 13, 1905, Sulman, Kirkpatrick-Picard & Ballot.

clxi

19,709 September 19, 1905, Sulman.
26,712 December 21, 1905, Sulman, Kirkpatrick-Picard & Ballot.
23,870 October 14, 1910, Minerals Separation, Limited, and Nutter.
23,949 October 15, 1910, Nutter, Hoover, and Minerals Separation, Limited.

Further answering plaintiffs' complaint as amended this defendant alleges:

That after the determination of the case of Minerals Separation, Limited, and another, v. James M. Hyde, in the above styled court, the said case was considered by the Circuit Court of Appeals for the Ninth Circuit, on appeal from the above styled court, and that the said Circuit Court of Appeals in May, 1914, reversed and set aside the decree of the above styled court in favor of the Minerals Separation, Limited, and another, and against James M. Hyde, and did declare the said patent No. 835,120 and all of the claims thereof, invalid and of no force or effect; that thereafter the said case of Minerals Separation, Limited, and another, vs. James M. Hyde reached the Supreme Court of the United States through a writ of certiorari and was thereafter argued before the said Supreme Court of the United States and a decision therein rendered by the Supreme Court of the United States, by which decision the decision and judgment of the Circuit Court of Appeals for the Ninth Circuit was reversed and set aside except that the Supreme Court of the United States did declare claims nine, ten and eleven of said patent
clxii No. 835,120 invalid and of no force or effect, and that said decision so declaring said claims invalid was rendered on the 11th day of December, 1916, and that said plaintiffs were, and each of them was, then and there on said date duly advised of the decision and order of the said Supreme Court of the United States upon the patent aforesaid and did know that the said Supreme Court of the United States had declared each and all of said claims nine, ten and eleven invalid and that said plaintiffs, have, and each of them has, wholly failed and unreasonably neglected and delayed the filing of a proper or any disclaimer in writing of the matters set forth in claims nine, ten and eleven in the patent office of the United States of America except in this, that Minerals Separation, Limited, on March 28th, 1917, did file a paper purporting to be a disclaimer of nine, ten and eleven, which said paper was wholly and totally inadequate and was not in fact or in law a disclaimer of said claims nine, ten and eleven in accordance with the decision and ruling of the Supreme Court of the United States; that said disclaimer was wholly insufficient in law or in fact to constitute a disclaimer at all; that

said disclaimer was not filed until after a supplemental answer was filed in this case by the above named defendant setting up as a defense that the said then plaintiff in this case had wholly failed to file a disclaimer as shown by the pleadings and files in this case. Defendant attaches hereto a copy of said alleged disclaimer marked Exhibit "B." That the said Minerals Separation, Limited, one of the plaintiffs above-named, was guilty of unreasonable neglect and delay in filing the said disclaimer and the said other plaintiffs herein have been guilty of unreasonable neglect and delay in filing the said disclaimer in writing; that by reason of the unreasonable
clxiii neglect and delay of the said plaintiffs, and each of them, to disclaim in writing each and all claims to claim nine, ten and eleven, the whole of said patent No. 835,120 has become wholly void and invalid and of no force or effect, and that the plaintiffs cannot, nor can any of them, rely thereon, nor maintain an action in equity under said patent and that the plaintiffs, are, and each of them is, now barred by reason of the said unreasonable delay and neglect and failure of each of them from any relief of any kind or nature in equity, nor can plaintiffs, or either of them now be given any assistance in a court of equity for any alleged invasion of alleged rights under said patent, nor can plaintiffs, or either of them, maintain an action for injunction or accounting, and that plaintiffs are, and each of them is, estopped from any further proceedings herein by reason of the unreasonable neglect or delay to file a proper, or any, disclaimer to claims held invalid by the Supreme Court of the United States as aforesaid and in accordance with the statutes of the United States of America in such cases made and provided; that the said defendant further alleges that the said plaintiffs have and each of them has wholly failed up to this time to file a proper disclaimer in the Patent Office of the United States as required by law.

By way of further defense herein defendant alleges that the said plaintiffs are, and each of them is, estopped from asserting or claiming that its said alleged patent, or any claim thereof is infringed by the use of an amount of oil exceeding five-tenths of one per cent. on the weight of the ore treated at a given time, for the reason
clxiv that the plaintiffs, Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, in a judicial proceeding, stated that the invention herein referred to was not practised by the use of an amount of oil in excess of five-tenths of one per cent. on the weight of the ore treated and by the further statements i na judicial proceeding that the invention was not reached until the amount of oil reached and fell below five-tenths of one per cent. on the ore treated; and that each of said statements was made in a judicial proceeding in a court having jurisdiction of the subject matter; that the plaintiff, Minerals Separation North American Corporation, claims to be the successor in interest of the other plaintiffs herein; that by reason of said statements the said plaintiffs are, and each of them is, now precluded and estopped from asserting in this court of equity that the invention embraced more than that described and claimed by them as aforesaid. Defendant alleges that said acts immediately last complained of did not occur until after the original

joining of issue herein and the defendant did not become acquainted with the said facts until November, 1916.

Wherefore, defendant, having fully answered, prays to be dismissed hence with its costs.

(Signed) THOMAS F. SHERIDAN,
W. A. SCOTT,
J. BRUCE KREMER,
T. H. SHERIDAN,
L. P. SANDERS,
ALF C. KREMER,
Solicitors for Defendant.

clxv UNITED STATES OF AMERICA,
District of Montana,
County of Silver Bow, ss:

J. L. Bruce, being first duly sworn on oath, deposes and says:

That he is an officer, to-wit: the Manager and also the agent of the above-named defendant, and makes this verification in said capacity for and on behalf of the above-named defendant; that he has read the foregoing answer to plaintiffs' complaint as amended, knows the contents thereof, and that the matters and things therein stated are true to the best of his knowledge, information and belief.

(Signed) J. L. BRUCE.

Subscribed and sworn to before me this 4th day of May, 1917.

[NOTARIAL SEAL.] C. K. TUOHY,
Notary Public for the State of Montana,
Residing at Butte, Montana.

My commission expires July 7th, 1918.

clxvi EXHIBIT A.

This agreement, made and entered into this 22nd day of July, 1911, by and between the Butte & Superior Copper Company, Limited, a corporation created and operating under and by virtue of the laws of Arizona, and doing business in Montana, party of the first part, and J. M. Hyde, party of the second part:

Witnesseth: Whereas, James M. Hyde claims that he has knowledge of a method of treating certain ores of the character of the ore produced in the Black Rock Mine, the property of the Butte & Superior Copper Company, Limited, by means of a process known as "The Gas Bubble Flotation Process," and whereas the said Hyde represents that in his best judgment an increased saving in the milling of said ores being treated by the Butte & Superior Copper Company, Limited, at the mill operated by the said Butte and Superior Copper Company, Limited, at Basin, may be made by the use of said process, and,

Whereas, the Butte and Superior Copper Company, Limited, is desirous of testing the efficiency of the said process with a view of

ascertaining whether or not the use of the said process will increase the saving of values at its said mill;

Now therefore, for and in consideration of the mutual promises and agreements of the parties hereto and the covenants and agreements hereinafter contained, the parties hereto do hereby agree as follows, to-wit:

clxvii The said Company agrees that it will furnish a sum not to exceed Twenty-five Hundred ($2,500.00) Dollars to be used by the said Hyde in the equipment and installation of a fifty (50) ton experimental plant for the use of the said flotation process at Basin, Montana, the said plant to be erected under the supervision of the said Hyde, he to have full charge of the erection of said experimental plant provided, however, that in the construction and operation of the said experimental plant the running of the mill now operated by the Butte and Superior Copper Company, Limited, shall in nowise be interfered with.

The said Company further agrees that the said Hyde may engage his own assistants for the operation of the said experimental plant provided that the payroll of the men employed by the said Hyde in the operation of the said experimental plant shall not exceed Forty ($40.00) Dollars per day, and the said Company agrees that it will pay the said payroll provided the sum does not exceeed Forty ($40.00) Dollars per day. It is expressly agreed and understood that the said Hyde shall receive no sum whatsoever as compensation either for the construction or operation of the said experimental plant save and except his personal expenses while engaged in mill work in the said Company's behalf, said sum not to exceed Five ($5.00) Dollars per day.

It is further agreed and understood by the said Hyde that said experimental plant shall be operated for a period of thirty (30) days after its completion, the said process above referred to to be used exclusively in the operation of said experimental plant and

clxviii that if in the judgment of the General Manager or Superintendent of the Butte and Superior Copper Company, Limited, the plant has not shown that the process used can increase the profits of said Company by at least twenty-five (25c) cents per ton on each ton of ore treated, the Company may at its option declare this agreement null and void and of no force and effect and neither party hereto shall have any further right or claim under this agreement.

It is further agreed that if in the judgment of said Hyde at the expiration of said thirty (30) days' test work in the experimental plant, it does not appear that the process can be used by the Company to enough profit to insure him a sufficient compensation to warrant him in giving further time to the business, he may declare this agreement null and void and of no effect after he has instructed an agent of the Company thoroughly in the details of the process and has released the Company from all further financial obligation to him other than the payment of his expense account as herein provided.

It is further agreed and understood that if the treatment of ore

in the said experimental plant has not indicated that the process can be operated to the financial benefit of the said Company the said Company shall so declare to the said Hyde and this agreement shall be null and void and neither party hereto will have any right or claim hereunder.

It is further agreed, however, that if in the judgment of the General Manager or Superintendent of the said Company, the said process is adaptable to the profitable treatment of the ore mined at the Butte and Superior Copper Company, Limited, mines at Butte,
clxix Montana, and that by the use thereof a sufficient financial saving can be made by the said Company to justify the adoption of the use of the said process, the Company will immediately furnish funds for the purpose of installing a plant sufficient in size to treat all ore not recovered as jig concentrates in the present plant operated by the said Company at Basin, Montana, when the mill is treating 400 dry tons per day, provided, however, that the total cost of said last mentioned plant shall not exceed ten thousand ($10,000.00) dollars.

The said Hyde agrees to furnish plans for the erection and construction of said last mentioned plant and further agrees to personally supervise the erection and construction of the said plant, and the said Hyde further agrees that he will make no charge whatsoever for his services in this connection save and except as hereinafter provided for and the said Hyde further agrees that after the completion of said last mentioned plant, he will supervise its operation in the use of the "Gas Bubble Flotation" process for a period of at least ninety (90) days and that during said period he will fully instruct an agent of the said Company in the operation of the said plant so thoroughly that the said agent of the said Company will be able to operate the said plant without the assistance of the said Hyde, provided, however, that the said Hyde shall not be obliged to devote more of his time to the personal supervision of the plant than in the judgment of the General Manager or Superintendent of the said Company is necessary to its successful operation or for the complete instruction of the said Company's
clxx agent. It is agreed and understood that during the erection of the last mentioned plant and during the operation of same the employees of the said Company may have full and complete access thereto, but that during the erection and the operation of the experimental plant the said Hyde shall have the right to exclude any and all persons from the building in which the said experimental plant is being constructed or operated.

It is agreed and understood that the said Hyde shall receive as full remuneration and compensation for all services rendered (excepting personal expense account as herein provided) a sum equal to one and two-thirds of every dollar of increased profit which shall accrue to the said Company through the operation of the said larger plant during any continuous period of thirty days which the said Hyde may select within the first ninety days that the said plant is operating after its final completion and during which the grade of ore treated has not averaged over twenty-one (21%) per cent. zinc

nor less than eighteen and one-half (18½%) per cent. zinc and the tonnage treated has been at least twelve thousand (12,000) dry tons during said period of thirty (30) days, it being understood and agreed that the said Hyde shall receive no further remuneration or compensation from the said Company save and except the said compensation to be paid said Hyde on the increased profits which have accrued to the Company during the said period of thirty (30) days so selected by the said Hyde.

It is especially agreed and understood that the basis of the increased profits of the said Company in the operation of the said entire
clxxi plant, upon which increased compensation of the said Hyde shall be based, shall be determined by comparing the profits of the operation of the entire completed plant, including the said flotation plant, with the operation of the said concentrating plant, in the following manner, to-wit:

1. The net smelter returns for the produce made during the thirty days so selected by the said Hyde during which time his compensation shall be estimated, shall be calculated on the basis of $5.20 per hundred weight, as the market price of spelter, f. o. b. cars St. Louis, Mo.

2. The milling cost of the concentrating plant as operated before the installation of the flotation equipment shall be assumed to be one dollar and fifty-one ($1.51) cents per dry ton of ore treated.

3. The recovery of the concentrator plant as operated before the installation of the flotation equipment shall be assumed to be seventy (70%) per cent. with the proportion and grade of concentrates, as follows, to-wit: 82% of zinc recovered as concentrate containing 50.8% zinc, no penalty; 5% of zinc recovered as concentrate containing 50.8% zinc, 50 cent screen penalty only; 13% of zinc recovered as concentrate containing 45.0% zinc, 50 cent screen penalty only.

4. In arriving at what shall constitute a dry ton of ore it is agreed that 2.6% of the railway weight shall be deducted from the ore treated during the said thirty days' period.

5. From the sum of the calculated net smelter returns of the concentrating plant after the flotation process has been installed shall be substracted the total cost of milling all ores in the Basin
clxxii plant including the flotation plant, the result thereof being a sum herein designated as "Total results."

6. From the calculated net smelter returns on the same amount and equal grade of ore as treated during the said 30 days on the basis of a seventy per cent. recovery with value as stated in paragraph No. 3, shall be substracted the total calculated cost of milling in the concentrating plant at Basin, exclusive of the flotation plant installed by the said Hyde, at the rate of $1.51 per ton of dry ore treated, the result thereof being a sum herein designated as "present Results."

7. The said Hyde shall receive as full compensation for his services hereunder a sum equal to one and two-thirds of the amount represented by substracting the sum herein referred to as "Present Results" from the sum herein referred to as "Total Results," that is

to say, if the sum represented as "Total Results" should be $100.00 and the sum represented as "Present Results" should be $60.00, the said Hyde shall receive as his full compensation one and two-thirds times $40.00, equal in amount to Sixty-six and two-thirds ($66.2/3) Dollars.

It is especially agreed and understood by and between the parties hereto that in no event shall the said Hyde receive as compensation for his services a sum in excess of $30,000.00.

It is especially agreed and understood that the said Company will at the expiration of any thirty continuous days' run of said mill and flotation plant during the said ninety days after the completion of the said flotation plant pay to the said Hyde as partial payment not to exceed fifty (50%) per cent. of the amount calclxxiii culated by the Superintendent of the Butte and Superior Copper Company, Limited, to be due him on the increased earnings, if any, during the said thirty days' period.

It is further agreed and understood that the remainder of the sum, if any, due to the said Hyde as compensation under this contract, shall be paid by the Butte and Superior Copper Company, Limited, upon receipt by the said Company of smelter returns on ores treated during the period, upon which the compensation of the said Hyde, if any, is based.

It is further agreed and understood that in all calculations provided for in this contract and in calculating the amount due said Hyde hereunder, all sums received or to be received by the Butte and Superior Copper Company, Limited, from the sale of lead concentrates shall be eliminated.

In witness whereof, the parties hereto have hereunto set their names and seals this day and year first above written.

BUTTE AND SUPERIOR COPPER
MINING COMPANY, LIMITED,
By A. B. WOLVIN, *Pres't.*
JAMES M. HYDE.

(Endorsed:) Agreement between Butte & Superior Copper Co., Limited, and J. M. Hyde.

clxxiv EXHIBIT B.

United States Patent Office.

Hon. Commissioner of Patents.

SIR: Your petitioner, Minerals Separation, Limited, a corporation organized and existing under the laws of Great Britain and having its principal place of business in London, England, hereby represents as follows:

1. That on November 6th, 1906, Letters Patent of the United States for Ore Concentration, No. 835,120, were granted to Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John

Ballot, of London, England, and your Petitioner is now the sole and exclusive owner of the said Letters Patent.

2. That by the decision of the Supreme Court of the United States in Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, vs. James M. Hyde, filed the 11th day of December, 1916, your Petitioner is advised that the said Letters Patent No. 835,120, in so far as concerns Claims 9, 10 and 11 thereof, covers and includes more than the said inventors had a right to claim as new;

3. That the matter which the said patentees and your petitioner are, in accordance with the said decision of the said Court, not entitled to hold or claim by virtue of said Claims 9, 10 and 11 of said Letters Patent No. 835,120, was included therein by mistake and without fraudulent or deceptive intent, and without any wilful default or intent to default or mislead the public,

clxxv 4. That the subject-matter not herein and hereby disclaimed is definitely distinguishable from the part or parts disclaimed therein, and is truly and justly the invention of the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, and is a material and substantial part of the thing patented.

Your Petitioner, therefore, for the purpose of complying with the requirements of the law in such case made and provided, and of disclaiming those parts of the thing patented which your Petitioner does not choose to claim or hold by virtue of said Letters Patent No. 835,120, does hereby disclaim from claims 9, 10 and 11 of said Letters Patent No. 835,120, any process of concentrating powdered ores excepting where the results obtained are the results obtained by the use of oil in a quantity amounting to a fraction of one per cent. on the ore.

In witness whereof your Petitioner has caused these presents to be signed and sealed by John Ballot, its duly constituted attorney in fact under and by virtue of a power of attorney dated December 14, 1915, and recorded in the United States Patent Office November 27, 1916, in Liber K. 101, Page 176 of Transfers of Patents, this 27th day of March, 1917.

MINERALS SEPARATION, LIMITED,
By JOHN BALLOT, [L. S.]
Attorney in Fact.

In the presence of:
S. GREGORY.
HENRY D. WILLIAMS.

clxxvi STATE OF NEW YORK,
County of New York, ss:

On this 27th day of March, 1917, before me personally came John Ballot, attorney in fact of Minerals Separation, Limited, a Company organized under the laws of Great Britain, to me personally

known, and known to me to be the individual described in and who, as such attorney, executed the within petition and acknowledged that he executed the same as the act and deed of Minerals Separation Limited, therein described, by virtue of a power of attorney duly *ex*-executed by said Minerals Separation, Limited, bearing date of December 14, 1915, which power of attorney was exhibited to me, and he states that it was still in force and effect.

[SEAL.] HARRY C. LEWIS,
Notary Public, Bronx Co., No. 12.

Certificate filed in New York County No. 41.

Service of the foregoing answer acknowledged and copy thereof received this 4th day of May, 1917.

O. W. McCONNELL,
HENRY D. WILLIAMS,
WM. HOUSTON KENYON,
Solicitors for Plaintiff.

(Filed May 4, 1917). Geo. W. Sproule, Clerk, by H. H. Walker, Deputy.

clxxvii Thereafter on the 25th day of August, 1917, the court rendered its opinion, and the same was filed herein, said opinion being in words and figures as follows, to-wit:

In the District Court of the United States for the District of Montana.

MINERALS SEPARATION, LIMITED, et al., Plaintiffs,

vs.

BUTTE & SUPERIOR MINING COMPANY, Defendant.

Court's Opinion.

Herein the Court finds the issues in favor of plaintiffs and against defendant—that the patent is valid as to all claims in issue. That defendant has infringed as charged and now infringes by the unlicensed use of the patent process all claims in issue save 5, 6 and 7. And therefrom the Court concludes plaintiffs are entitled to recover of and from defendant in accordance herewith and the prayer of the bill. The decision and opinion attached is made a part hereof.

August 25th, 1917.

BOURQUIN, *J.*

clxxviii This is trial on the merits of the suit reported in 237 Fed. 401.

It involves the patent and claims of the Hyde suit wherein the Supreme Court (242 U. S. 261) held the patent valid, but some claims invalid. The issues are as in the Hyde suit, viz.: novelty, invention, infringement and in addition defenses of unreasonable delay

and defects in disclaimer of the invalid claims, and estoppel, by reason of statements by plaintiff's counsel to the Supreme Court in arguing the Hyde suit. The evidence herein is that submitted during twenty-five days and also the record in the Hyde suit. So far as heretofore known the nature and history of the discovery and invention (a process of ore concentration by air flotation) are fairly set out in reports of the Hyde suit (242 U. S. 261, 214 Fed. 100; 207 Fed. 956) of the Miami suit (244 Fed. 752; 237 Fed. 609), and of foreign suits cited in a footnote on page 745, 244 Fed. This suit is an important contribution and yet it discloses that though the use of the process is very wide, extensive and growing, its simplicity, economy and success still surprise and gratify the metallurgical world and its laws or principles of operation still interest and puzzle the scientist. "In the beginning it was very little knowledge and mostly guesswork and since then there has been every year a little more knowledge and still a great deal of guesswork," testifies one of the defendant's experts, Professor Bancroft of Cornell, a physical chemist of note, acquainted with the process since 1906 and lecturer upon it since 1912.

clxxix Though speaking for himself alone, the learned doctor's estimate might well be applied to all, practical layman and expert scientist alike.

At the same time, though heretofore somewhat ambiguous and obscure, present knowledge warrants the conclusion that the gist of this remarkable and valuable process and the actual discovery and invention are that whereas theretofore in ore concentration air had been used in desultory and fugitive bubbles as a makeshift incident of and supplemental to oil and skin flotation, air can be made to do all the work by creating in water-ore pulp modified by a suitable oily contaminant, an infinitude of bubbles.

It is the first of its kind and the patent sufficiently discloses it and methods to those skilled in the art.

Ambiguity and obscurity were as much due to the extreme mechanical simplicity of the process as to the inability then and now to know and e plain all its laws or principles. The tendency was to attach prime importance to reduction in amount of oil used, when in fact this is but a necessary incident (for which there are substitutes if not equivalents) to the creation of the infinitude of bubbles that do the work. Despite this tendency and to overlook the simple and obvious the patent fairly clearly sets out the various ways and means to create this infinitude of bubbles and that they do the work.

The tests to determine which kind and amount of "oily substance yields the proportion of froth or scum desired," that flotation is "mainly from the inclusion of air bubbles," the froth, the agitation,

clxxx all are so many guides i nthe patent, pointing the skilled operator to and including the infinitude of bubbles and the degree of agitation and amount of soap or oil to produce such bubbles, as surely as the word "crystal-ization" points to appropriate temperature in Commercial Co. vs. Co. 135 U. S. 189, and the words "uttered sound" by the "human voice" to articulate speech in the Telephone Cases, 126 U. S. 531.

Of the new evidence herein are learned dissertations upon the

philosophy of the process,—upon the philosophy of bubbles, the heart of it, by Professors Bancroft of Cornell, and Taggart and Beach of Yale, and Drs. Sadtler of Philadelphia and Grosvenor of New York. From these it is gathered that the mere introduction of particles of air into a liquid does not create bubbles, but that they are created by subsequent agitation, either applied or self-agitation. Air particles introduced into pure water are incapable of creating bubbles. The reasons are the surface tension of the water and the lack of viscosity to create a sufficient film about the air particle compel the escape of the air particles into the atmosphere and no bubble is formed. Some soaps and oils possess the quality to lessen this surface tension of water and to give or increase this necessary viscosity. Their addition in appropriate quantity to water enables air particles introduced therein to create bubbles. Rather the meeting and co-action of water, oil and air create a film composed of all three and which surrounds the air particles. This film is more viscous than the mass of the water, and rising to the surface, the tension of which (and of the films) has been reduced by the oil, maintains itself as an air bubble. This quality of oil is of first importance in the
clxxxi process. Another of lesser importance and which all oils possess is the "preferential affinity for metalliferous matter over gangue." Of lesser importance, because it is now known (and patented) that given another contaminant than oil but which possesses the like bubble-making quality though not the said "preferential affinity," the process is equally successfully worked. Air also possesses this "preferential affinity," and in view of the foregoing it well may be that the capture as well as the flotation of the metallic particles is more due to the great volume of air than to the infinitesimal oil. That in this process air without oil cannot capture and retain the metallic particles, seems, due to its inability to create bubbles without oil. And why this capture in any case, is still of the unsolved phenomena of the process. On the other hand, water has a preferential affinity for gangue over metalliferous matter. That is, it wets the former more readily than it does the latter. And this contributes to the process, in that oil and air displace water from the surface of metalliferous matter more easily and quickly than from gaugue, and so more readily capture and float the former than the latter. At the same time, despite these preferential affinities, in successful operation of the process the bubbles generally float more gangue than metal, more in quantity but not in proportion, and why is also unsolved.

There are "critical proportions" of any oil used in this process, perhaps not a sharp divide but rather a broad one. For the amount of oil to produce sufficient and efficient bubbles must depend
clxxxii on many other factors, viz.: the working cell space, amount of water, degree of agitation, kind and amount of ore and perhaps on occasion amount of metallic content, kind of oil, etc. For example, if a ton of ore be agitated in a lake of water, doubtless a lake of oil will be necessary to create sufficient bubbles to capture the metal in the ore. But with bona fide operations in a good workmanlike manner—with the proportion of space, water, agitation, etc., such

operations and manner dictate, the range in amount of oil will be narrow and well within one per cent. on the ore. These "critical proportions" are like those known to and solved by every child with its pipe and bowl of suds. Too little soap, the bubbles are few, small, fragile, and break quickly. Too much soap, they flow from the pipe in a torrent, are heavy, and refuse to float. The right amount of soap, the "critical proportions," his bubbles are large, detach readily and float high, far and for long. So is it with the bubbles in this process. With excess oil, but not enough to defeat bubbles altogether, though of fair aspect to the eye the bubbles will not do the work. In the excess oil in the films the metallic particles do not cling but swim or slide to the bubble's lower surface, "neck off"—detach, and sink. The untechnical workman recognizes there are "critical proportions" of oil, and small deviation from the predetermined amount in the feed, whether more or less, manifests itself to him in the appearance of the froth and poorer results; and he knows and remedies the error in oil.

clxxxiii Metallic content of ore seems of little importance—sometimes seems to require oil inversely. For example, a local operator with the process upon ore from the same vein as defendant's, uses .7 lb. of oil per ton of ore of 11.23 per cent zinc content, making 50.59 per cent concentrates with 94 per cent recoveries, and in the same plant uses 2.83 pounds of the like oil per ton of tails of .97 per cent copper content, making 9.085 per cent concentrates and .266 per cent tails. It is apparent it is the air and not at all the oil that floats the mineral, noting that in the first of this example 211 pounds of zinc are floated by air bubbles in the creation of which only .7 lb. of oil is used. How the air particles are introduced into the pulp is immaterial. For introduced, they are still particles and not bubbles. Agitation subsequent to introducton is vital and alone can convert air particles into water-oil-air bubbles. It is this subsequent agitation that within the claims of the patent agitates "the mixture until the oil coated mineral matter forms into a froth" or "to form a froth." And it is all one whether this be applied agitation or self-agitation—the agitation set up by the air particles themselves in merely rising through the mass and thereby coming in contact with both water and oil, all co-acting to form bubbles which capture the metal. The mineral particles, either oiled before or by contact with bubbles, attach to and enter the viscous film of the bubbles. The particles also increase the viscosity of the bubble films, armor them and increase their stability, perhaps as stays that decreasing the area of unsupported surfaces, increase the latter's ability to resist rupture.

clxxxiv The great mass of new evidence herein is but cumulative of the Hyde suit. The only new publication is the California Journal of Technology detailing a suggestive but rather misleading and abandoned experiment sufficiently referred to and disposed of in the Miami suit.

There is much evidence that progress in the process and methods of operating it, now discloses that with some ores and some oils or mixtures of oils, the process can be fairly successfully operated with

one per cent and more of oil. This is really admitted by plaintiff and is taken as proven. But it is also proven practically without conflict that in all the operations with this process not to exceed .2 per cent of oil is used, save by defendant and others in like situation and only since the decision in the Hyde suit and solely to avoid infringement; that some oils are effective and more are ineffective to operate the process; and that the excess oil used is useless, wasted and harmful.

But the defendant contends that this evidence demonstrates the process lacks novelty and invention, and that because of it the record is substantially different from the Hyde suit, the decision there should not control here, and the patent is and ought to be held invalid. This is without support in the patent and Hyde decision.

In describing the invention the patent refers to Cattermole, and says that the patentees "have found that if the proportion of oily substance be considerably reduced,—say to a fraction of one per cent on the ore," after vigorous agitation the metallic particles rise
clxxxv to the surface in a froth; that the proportion thereof varies considerably with different ores and different oils, and so it is necessary to test "to determine which oily substance yields the proportion of froth or scum desired." An example of a particular ore and oil is of oil "say from .02 per cent. to 0.5 per cent. on the weight of ore," wherein on cessation of agitation "a large proportion of the mineral present rises to the surface in the form of a froth or scum which has derived its power of flotation mainly from the inclusion of air bubbles introduced in the mass by the agitation, such bubbles or air-films, adhering only to the mineral particles which are coated" with the oil which has "a preferential affinity for metalliferous matter over gangue." It adds that the minimum of that oil "may be under .1 per cent. of the ore, but this proportion has been found suitable and economical."

The claims are: (1) For "oily liquid * * * to a fraction of 1 per cent. on the ore"; (2) For oleic acid "to 0.02—0.5 per cent. on the ore"; and (3) For "a small quantity of oil." These last were held invalid. In upholding the patent the Supreme Court says that "as described and practiced" the process consists "in the use of an amount of oil which is 'critical' and minute as compared with the amount used in prior processes 'amounting to a fraction of 1 per cent. on the ore,' and in so impregnating with air the mass * * * by agitation * * * as to cause to rise to the surface * * * a froth * * * which is composed of air bubbles with only a trace of oil in them, which carry in mechanical suspension a very high percentage of the metal"; that "it differs so essentially
clxxxvi from all prior processes in its character, in its simplicity of operation, and in the resulting concentrate, that we are persuaded that it constitutes a new and patentable discovery"; that the facts are not overstated by Liebmann that "The present invention differs essentially from all previous results. It is true that oil is one of the substances used but it is used in quantities much smaller than was ever heard of, and it produces a result never obtained be-

fore. The minerals are obtained in a froth of a peculiar character, consisting of air bubbles which in their covering film have the minerals embedded in such matter that they form a complete surface all over the bubbles. A remarkable fact with regard to this froth is that, although the very light and easily destructible air bubbles are covered with a heavy mineral, yet the froth is stable and utterly different from any froth known before, being so permanent in character that I have personally seen it stand for twenty-four hours without any change having taken place. The simplicity of the operation, as compared with the prior attempts, is startling. All that has to be done is to add a minute quantity of oil to the pulp to which acid may or may not be added, agitate for from two and one-half to ten minutes and then after a few seconds collect from the surface the froth which will contain a large percentage of the minerals present in the ore"; that the court is convinced "that the small amount of oil used makes it clear that the lifting force which separates the metallic particles of the pulp from the other substances of it is not to be found principally in the buoyancy of the oil used, as was the case in prior

clxxxvii processes, but that this force is to be found, chiefly, in the buoyancy of the air bubbles introduced into the mixture by an agitation greater than and different from that which had been resorted to before, and that this advance on the prior art and the resulting froth concentrate so different from the product of other processes make of it a patentable discovery as new and original as it has proved useful and economical"; that the court agrees with the House of Lords' decision; that the process is not one before described but a new method in which flotation is by the "buoyancy of air bubbles"; that tests to determine the necessary "amount of oil and the extent of agitation," and "the range of treatment within the terms of the claims," satisfy the law; but that while the patentees "discovered the final step, precedent investigations were so informing that this final step was not a long one and the patent must be confined to the results obtained by the use of oil within the proportions often described in the testimony and in the claims of the patent as 'critical proportions' 'amounting to a fraction of 1 per cent on the ore' and therefore * * * the patent is valid as to claims Nos. 1, 2, 3, 5, 6, 7, and 12 * * * but * * * invalid as to claims 9, 10 and 11." Those held invalid are those heretofore referred to as (3). It seems clear neither patent nor decision undertakes to say the process depends upon less than 1 per cent of oil or is inoperative with 1 per cent or more of oil.

It is true that in the beginning and during the Hyde suit the pat-

entees inclined to so believe or at least believed better re-

clxxxviii sults would be obtained by a fraction of 1 per cent of oil. Perhaps limited investigations and experience with few ores and oils justified the belief. Indeed, all experience to date, plaintiffs', defendant's, strangers', demonstrates that with any ore and any efficient oil, less than 1 per cent of oil gives better results, all circumstances considered. The "critical proportions" referred to seem absent, in terms, from the patent, and ought not to be adversely inferred in disregard of construction in favor of the patentee

where the patent is ambiguous. The patent describes oil "considerably reduced," and refers to a "fraction of 1 per cent," by way of example. And though some claims limit oil to such fraction, and a limited range within it, others are for "a small quantity" and for that reason held invalid by the Supreme Court. With the later knowledge of this suit it is doubted that such would be the decision now. It is to be observed that this limitation of the patent indicates the Supreme Court believed the process might be operative with 1 per cent and more of oil, and contemplated that this would not defeat the patent, but might affect infringement. If the patent is limited to the use of a fraction of 1 per cent of oil, that the process can be operated with 1 per cent and more is not material to validity, though it may be to infringement. For if a patentee limits his claim voluntarily or because he does not know the extent of his invention, he abandons the excess and the patent is valid to the extent of the claim. If it be conceded that new evidence might warrant and demand that a trial court hold invalid a patent by the Supreme Court held valid, such evidence must be unequivocal, clear and
clxxxix convincing, in quality and quantity that inspires confidence and produces conviction that the patent is invalid and that the Supreme Court would so determine beyond a reasonable doubt. Not only does it fail here, but it strengthens the conviction that the patent is valid.

The disclaimer to conform to the Supreme Court's decision that claims 9, 10 and 11 are invalid, was filed 107 days after said decision and after mandate but before expiration of time for rehearing. It was timely filed. In substance it fairly conforms to the language of the decision, disclaiming "from claims 9, 10 and 11 * * * any process of concentrating powdered ores excepting where the results obtained are the results obtained by the use of oil in a quantity amounting to a fraction of 1 per cent on the ore." The parties differ in its interpretation even as they do in respect to the decision. Written words, not oral claims, control. The patent claims included what the patentees were entitled to and more. The decision pointed out the excess. The patentees disclaim the excess. They can safely rely upon the decision and a disclaimer conforming to the language of the decision is sufficient. The patent valid, defendant admits infringement from before suit commenced to January 7, 1917, and denies infringement thereafter. During the period of admitted infringement it applied the process to some 1,598,000 dry tons of crushed ore tailings from water concentration, of mineral zinc content by yearly averages as follows: 1913, 15.14 per cent; 1914, 14.14 per cent; 1915, 13.66 per cent; 1916, 12.89 per cent.

exc Oil used by yearly averages is as follows: 1913, 5.58 pounds; 1914, 2.22 pounds; 1915, 1.49 pounds; 1916, 1.43 pounds.

The concentrate grade by yearly averages is as follows: 1913, 47.60 per cent; 1914, 53.03 per cent; 1915, 54.62 per cent; 1916, 53.83 per cent, and recoveries (apparent) likewise are for 1913, 80.03 per cent; 1914, 86.08 per cent; 1915, 90.18 per cent; 1916, 92.63 per cent.

Progress is indicated by leaner ores, less oil, higher grade concentrates, greater recoveries, all coincident with advancing time.

It is noted that the process is responsible for advance in methods, devices and machines for its operation. To briefly describe defendants during infringement admitted the water-concentrate tailings, oil added, flowed to the head of a pyramid machine of seven cells in series, each cell containing a revolving perpendicular spindle and horizontal blades and having two opposed spitzkasten. The agitation was very violent. The tails from each cell flowed by gravity to the cell immediately below, those from the last cell flowing to Callow air cells which produced froth middlings returning to the head of the pyramid, and tails, to waste. The first three cells of the pyramid produced froth rougher concentrates which flowed to cleaners, and the other cells produced froth middlings which returned to the head of the pyramid. The rougher concentrates passed through five cleaner cells for washing. This produced concentrates which flowed to and through five re-cleaner cells, and tails which returned to the
exci head of the pyramid. The re-cleaners produced final concentrates and tails which returned to the head of the cleaner. Commencing January 7, 1917, the defendant's methods are as before, save pneumatic as well as mechanical agitation is employed in the lower four cells of the pyramid. Some spitzkasten are blocked, an additional cleaner operation is used, and from which for some unexplained reason 8.65 per cent zinc tails go to waste, and oil in amount 1 per cent and more on the ore is used. Defendant not very insistently claims results for this latter period are more profitable than for the former, but plaintiffs' analysis, neither denied nor criticized, and beyond both, of defendant's reports and tabulations makes manifest the fact is otherwise to the extent of about $1.75 per ton of ore—an enormous loss on 45,000 tons monthly. There is considerable like testimony in reference to operations by other infringers. However, coming as it does after very large operations, investigations and experiments of several years, after the Supreme Court's decision in the Hyde suit, it is incredible that use of 20 pounds of oil per ton results in more profit than one and a half to four pounds per ton. If it does, these great concerns would not have waited to discover the fact and employ it, until after the said decision. Defendant practically admits that it now uses the present amount of oil merely to avoid the patent. It is done, says its counsel in argument, "because the Supreme Court has said it is not at liberty to use less than one-half per cent," and "out of abundance of caution" it uses "more than 1 per cent." The evidence likewise persuades. If the excess
excii oil were effective and useful and not inert, useless and harmful, it would be without the claims of the patent, would be of that the patentees abandoned to the public, and would involve no infringement.

Plaintiffs somewhat laboriously argue that though the Supreme Court held that the claim for use of "a small quantity of oil" to produce froth is too broad and so invalid yet since the court identifies the invention by the "results obtained" though confining it to the "results obtained" by the use of oil "amounting to a fraction of 1

per cent on the ore," the import of the decision is that if the results obtained by operation of the process with oil in amount 1 per cent and more on the ore are like and the same results obtained with a fraction of 1 per cent of oil, it is within the patent and is infringement. This is more ingenious than sound, and would deprive the decision of effect. The court does not confine the patent to the like or same results obtained, but to the results obtained by the use of a fraction of 1 per cent of oil on the ore. It is believed, however, that the court employed the word "use" in its, or the ordinary sense of beneficial service. Patent law is not concerned with the useless, and a valuable result sought is not "obtained" by but despite the use of an excess of an essential ingredient, which excess renders no or ill-service. From the evidence it appears the larger part of the oil used by defendant and all in excess of a fraction of 1 per cent on the ore, if not inert is ineffective, wasted and injurious to the process and results. Before January 7, 1917, defendant used only pine oil and about 1.43 pounds per ton of ore, with excellent results.
exciii Since said date it uses a mixture of 20 to 24 pounds of oil per ton of ore, made up of 18 per cent of pine oil, 12 per cent of kerosene oil, and 70 per cent of fuel oil, with poorer results. The kerosene and fuel oil are petroleums. As before stated many oils are ineffective to operate the process and that is because they have not the quality that contributes to bubble-making. What this quality consists of, wherein it lies, does not appear. With these ineffective oils, agitation will not produce froth and so there is no flotation of the metallic particles. One of defendant's witnesses testifies that in the laboratory and plant of the Utah Copper, one thousand oils have been tried, of which but two mixtures give satisfaction. Petroleums seemed generally ineffective, by the evidence of both parties, though some of defendant's witnesses testify to sometimes successful experiments with them. Incidentally, there is suspicion that with experiments as with figures, can be done anything for or against, without impropriety in the operator. Some petroleums are used in limited quantities but always in combination with a recognized bubble-making oil, and only, it is said, for a somewhat bubble stabilizing effect. Defendant's present mixture of oil contains more pine oil on the ore than it used alone before January 7, 1917. The other factors the same, it is obvious the excess petroleums in the mixture are responsible for the poorer results.

Defendant uses the patent process, uses plaintiff's invention of ore concentration by air bubble flotation, uses the same elements in the same combination in the same way with the same function
exciv to the same, but poorer results; and exceeding the patent claims in reference to one ingredient (oil) uselessly, wastefully and injuriously and merely with intent to avoid the letter of the patent does not avoid infringement. The addition of the excess oil no more adds to or changes the process, no more avoids infringement, than would the addition of milk or other useless substance not a part of the process. The excess oil either exercises nó function or less efficiently exercises the same function in the same way as the limited oil and to the same but poorer results. To secure to patentees

their invention, the law looks quite through mere devices and forms, to the substance of things. And if in substance the invention is taken, if the thing that does the work is taken, all devices to evade the letter of the patent avail nothing to escape the consequences of infringement. Neither principle nor authority to the contrary, is cited or known to the court.

In the matter of estoppel affecting infringement, it suffices to say neither in pleading nor proof do the elements of estoppel appear. Although the evidence is of great volume and the arguments of relative length, all have been carefully considered but require no additional reference herein.

The patent is valid in respect to all claims involved. Defendant throughout has infringed and now infringes all said claims save 5, 6 and 7, and decree accordingly.

BOURQUIN, *J.*

cxcv Thereafter on the 17th day of September, 1917, the court entered decree herein and the same was filed and entered on September 17th, 1917, said decree being as follows, to-wit:

At a Stated Term of the United States District Court in and for the District of Montana, Held at the Court Rooms, in the Federal Court Building, in the City of Butte, in said District, this 17th Day of September, 1917.

Present: Hon. George M. Bourquin, District Judge.

In Equity.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Interlocutory Decree.

This case came on for trial and was tried in open court on April 16, 17, 18, 19, 20, 23, 24, 25, 26, 27, 28 and 30, May 1, 2, 3,
cxcvi 4, 5, 7, 8, 9, 10, 11, 12, 14, 15, 16 and 17, 1917, and was argued by counsel Henry D. Williams, William Houston Kenyon and Lindley M. Garrison, Esquires, in behalf of the plaintiffs, and Walter A. Scott, Thomas F. Sheridan and J. Bruce Kremer, Esquires, in behalf of the defendant; and thereupon it is ordered, adjudged and decreed as follows, viz.:

That the Letters Patent of the United States issued to Henry L. Sulman, Hugh F. K. Picard and John Ballot on November 6, 1906,

No. 835,120, for improvements in Ore Concentration are good and valid in law as to claims 1, 2, 3, 5, 6, 7 and 12, and are good and valid in law as to claims 9, 10 and 11 as limited by the disclaimer filed in the United States Patent Office on the 28th day of March, 1917.

That the said Henry L. Sulman, Hugh F. K. Picard and John Ballot were the true, original, first and joint inventors of the invention described in the said Letters Patent, and particularly pointed out in claims 1, 2, 3, 5, 6, 7 and 12, and claims 9, 10 and 11 as limited by the aforesaid disclaimer filed on March 28, 1917.

That the plaintiffs are the full and exclusive owners of all right, title and interest in and to said Letters Patent as set forth in the Bill of Complaint and the Supplemental Bill of Complaint.

That processes employed by defendant Butte & Superior Mining Company, both before and after the filing of the Bill of Complaint herein and to and including January 7, 1917, embodied the invention of said Letters Patent No. 835,120 in suit, and in-
cxcvii fringed claims 1, 2, 3, 5, 6, 7 and 12 thereof, and claims 9, 10 and 11 as limited by said disclaimer; and that processes employed by the defendant from the 7th day of January, 1917, down to and through the time of trial, embodied the invention of Letters Patent in suit No. 835,120, and infringed claims 1, 2, 3 and 12 thereof, and claims 9, 10 and 11 as limited by the aforesaid disclaimer.

That a permanent injunction issue out of and under the seal of this Court, directed to the defendant and restraining the defendant, its confederates, associates, officers, servants, agents, clerks and workmen from any installation or use in any manner of the said patented invention, and particularly claims 1, 2, 3, 5, 6, 7 and 12 thereof, and claims 9, 10 and 11 as limited by the said disclaimer, or any part thereof, in violation of the rights of the plaintiffs as aforesaid, and from encouraging and inducing others to infringe the said Letters Patent, and from defending other infringers of said Letters Patent, or reimbursing them the expense of defending against said Letters Patent, in whole or in part, or otherwise aiding or abetting others to install or use processes of ore concentration in infringement of said Letters Patent.

That the plaintiffs do recover of the defendant the profits which the defendant has derived, received or made by reason of the aforesaid infringement, and that plaintiffs do also recover from the defendant any and all damages sustained by the plaintiffs by reason of said infringement; and it is hereby referred to one hereafter to be named as a master of this Court to take and state the
cxcviii account of such gains, profits and advantages, and to assess such damages and to return thereon with all convenient speed, and the defendant, its confederates, officers, servants, agents, clerks and workmen are hereby directed and required to attend the aforesaid master from time to time as required, and to produce before him such books, papers and documents as relate to the matters at issue, and to submit to such oral examination as the Examiner may

require, or such account to be taken and stated by the Court, as the Court may hereafter order.

Sept. 17, 1917.

BOURQUIN, *J.*

Filed and entered Sept. 17, 1917. Geo. W. Sproule, Clerk.

excix In the District Court of the United States, for the District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Assignment of Errors.

Comes now the defendant above-named and files the following assignment of errors upon which it will rely upon the prosecution of its appeal to the United States Circuit Court of Appeals for the Ninth Circuit, from the decree made by this honorable court on the 17th day of September, 1917, in the above styled cause:

1. The court erred in finding, holding and decreeing that the Letters Patent of the United States issued to Henry L. Sulce man, Hugh F. K. Picard and John Ballot on November 6th, 1906, and numbered 835,120 for improvements in ore concentration were each and all of said claims involved, to-wit: claims 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12, good and valid in law.

2. The court erred in finding, holding and decreeing that the defendant has infringed said Letters Patent 835,120 as to claims 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12, or any of said claims.

3. The court erred in finding, holding and decreeing that said Henry L. Sulman, Hugh F. K. Picard and John Ballot were the true, original, first and joint inventors of the invention described in said Letters Patent 835,120, and particularly pointed out in claims 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12 thereof.

4. The court erred in finding, holding and decreeing that said Henry L. Sulman, Hugh F. K. Picard and John Ballot were the true, original, first and joint inventors of the invention described in said Letters Patent 835,120, as set out in claims 9, 10 and 11, as limited by the disclaimer filed in the United States Patent Office on the 28th day of March, 1917.

5. The court erred in finding, holding and decreeing that claims 9, 10 and 11 of said patent as limited by the disclaimer filed in the

United States Patent Office on the 28th day of March, 1917, are good and valid in law.

6. The court erred in finding, holding and decreeing that the plaintiffs are the full and exclusive owners of all right, title and interest in and to said Letters Patent as set forth in the Bill of Complaint and the Supplemental Bill of Complaint.

cci 7. The court erred in finding, holding and decreeing that the processes employed by the defendant, Butte and Superior Mining Company, both before and after the filing of the Bill of Complaint, and to and including January 7th, 1917, embodied the invention of said Letters Patent 835,120, or infringed claims 1, 2, 3, 5, 6, 7 or 12 thereof, or claims 9, 10 or 11 thereof, as limited by said disclaimer filed in the United States Patent Office on the 28th day of March, 1917.

8. The court erred in finding, holding and decreeing that processes employed by the defendant from the 7th day of January, 1917, down to or through the time of trial, embodied the invention of Letters Patent No. 835,120, or infringed claims 1, 2, 3 or 12 thereof, or claims 9, 10 or 11, as limited by the aforesaid disclaimer filed in the United States Patent Office on the 28th day of March, 1917.

9. The court erred in finding, holding and decreeing that a permanent injunction issue out of and under the seal of said court directed to the defendant, Butte and Superior Mining Company, and enjoining or restraining said defendant, its associates, officers, servants, agents, clerks or workmen, from any installation or use in any manner of the said patented invention, or any part thereof, or particularly claims 1, 2, 3, 5, 6, 7 or 12 thereof, or claims 9, 10 or 11, as limited by said disclaimer filed in the United States Patent Office on the 28th day of March, 1917, in violation of the rights of the plaintiffs, or either of them.

10. The court erred in finding, holding and decreeing that the said defendant, or its officers, agents, servants or employees

ccii be restrained from participating in any litigation whatsoever, or installing, using, or directing the installing or use of, or advising the installation or the use of the processes of ore concentration described in said Letters Patent.

11. The court erred in finding, holding and decreeing that the plaintiffs do recover of the defendant the profits which the defendant has derived, received or made by reason of the aforesaid infringement, and that plaintiffs do also recover from the defendant any and all damages sustained by the plaintiffs by reason of said infringement.

12. The court erred in finding, holding and decreeing that, a master of said court, take and state the account of such gains, profits and advantages, and assess such damages and to return thereon with all sufficient speed, to the said court, and that the defendant, its officers, servants, agents, clerks or workmen, or associates, be directed and required to attend the aforesaid master and to produce before him books, papers or documents relating to the matters at

issue, and to submit to such oral examination as the examiner or master may require.

13. The court erred in entering an interlocutory decree in said cause in favor of the plaintiffs and against the defendant.

14. The court erred in holding that the use of oil in amounts outside of the critical proportions, namely, above one-half of one per cent (.5%) as the upper limit, and .02% as the lower limit, in a process of ore concentration is disclosed and covered in said Letters Patent 835,120.

cciii 15. The court erred in holding that the said defendant, Butte and Superior Mining Company, infringed claims 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12, and each of them, by the use of oil in quantities above one-half of one per cent (.5%) on the ore in its operation of ore concentration.

16. The court erred in holding that said Letters Patent 835,120 disclosed and covered any amount of agitation, violent or otherwise.

17. The court erred in holding that the said plaintiffs had properly disclaimed the original claims 9, 10 and 11 of patent 835,120.

18. The court erred in holding that the plaintiffs had not been negligent or had not unduly delayed the filing of the alleged disclaimer.

19. The court erred in holding that said disclaimer was filed within the time and in the manner required by law, such disclaimer having been filed on the 28th day of March, 1917; said disclaimer being in words and figures as follows, to-wit:

United States Patent Office.

Hon. Commissioner of Patents.

SIR: Your Petitioner, Minerals Separation, Limited, a corporation organized and existing under the laws of Great Britain and having its principal place of business in London, England, hereby represents as follows:

cciv 1. That on November 6th, 1906, Letters Patent of the United States for Ore Concentration, No. 835,120, were granted to Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, of London, England, and your Petitioner is now the sole and exclusive owner of the said Letters Patent.

2. That by the decision of the Supreme Court of the United States in Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, vs. James M. Hyde, filed the 11th day of December, 1916, your Petitioner is advised that the said Letters Patent No. 835,120, in so far as concerns Claims 9, 10 and 11 thereof, covers and includes more than the said inventors had a right to claim as new.

3. That the matter which the said patentees and your Petitioner are, in accordance with the said decision of the said Court, not entitled to hold or claim by virtue of said claims 9, 10 and 11 of said Letters Patent No. 835,120, was included therein by mistake, and

without fraudulent or deceptive intent, and without any wilful default or intent to defraud or mislead the public.

4. That the subject-matter not herein and hereby disclaimed is definitely distinguishable from the part or parts disclaimed herein, and is truly and justly the invention of the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, and is a material and substantial part of the thing patented.

Your petitioner, therefore, for the purpose of complying with the requirements of the law in such case made and provided, and of disclaiming those parts of the thing patented which your
ccv Petitioner does not choose to claim or hold by virtue of said Letters Patent No. 835,120, does hereby disclaim from claims 9, 10 and 11 of said Letters Patent No. 835,120, any process of concentrating powdered ores excepting where the results obtained are the results obtained by the use of oil in a quantity amounting to a fraction of one per cent. on the ore.

In witness whereof your Petitioner has caused these presents to be signed and sealed by John Ballot, its duly constituted attorney in fact under and by virtue of a power of attorney dated December 14, 1915, and recorded in the United States Patent Office November 27, 1916, in Liber K 101, page 176 of Transfers of Patents, this 27th day of March, 1917.

MINERALS SEPARATION, LIMITED,
By JOHN BALLOT, [L. S.]
Attorney in Fact.

In the presence of:
S. GREGORY.
HENRY D. WILLIAMS.

ccvi STATE OF NEW YORK,
County of New York, ss:

On this 27th day of March, 1917, before me, personally came John Ballot, attorney in fact of Minerals Separation, Limited, a Company organized under the laws of Great Britain, to me personally known, and known to me to be the individual described in and who, as such attorney, executed the within petition and acknowledged that he executed the same as the act and deed of Minerals Separation, Limited, therein described, by virtue of a power of attorney duly executed by said Minerals Separation, Limited, bearing date of December 14, 1915, which power of attorney was exhibited to me, and, he stated that it was still in force and effect.

[SEAL.] HARRY C. LEWIS,
Notary Public, Bronx Co., No. 12.

Certificate filed in New York County No. 41.

$10.00 Recd. Mar. 28th, 1917, C. C. U. S. Pat. Office.

Disclaimer recorded March 28—1917.

20. The court erred in finding, holding and decreeing that said disclaimer was in fact or in law a disclaimer at all.

ccvii 21. The court erred in holding that said disclaimer complied with the requirements of the statutes of the United States with reference to the filing of disclaimer so as to preserve and retain the portion of the patent not disclaimed or relinquished or returned to the public domain.

22. The court erred in holding that the said alleged disclaimer was properly executed.

23. The court erred in holding that the said alleged disclaimer was executed by the necessary party or parties.

24. The court erred in holding that a disclaimer was ever filed.

25. The court erred in holding that the said plaintiffs were not estopped by the admission of its counsel, W. H. Kenyon, Esq., when before the Supreme Court of the United States in the case of Minerals Separation, et al. vs. James M. Hyde, wherein the said W. H. Kenyon stated to the court what constituted the invention disclosed and covered by said patent 835,120, and particularly wherein he stated to the court that the said invention "was just coming into being when the amount of oil was reduced to one-half of one per cent."

26. The court erred in not dismissing the action of the plaintiffs for want of equity.

THOS. F. SHERIDAN,
J. EDGAR BULL,
J. BRUCE KREMER,
Solicitors for Defendant.

ccviii Service of the foregoing assignment of errors acknowledged and copy thereof received this 20th day of September, 1917.

HENRY D. WILLIAMS,
W. H. KENYON,
LINDLEY M. GARRISON,
O. W. McCONNELL,
Solicitors for Plaintiffs.

Filed Sept. 20, 1917. Geo. W. Sproule, Clerk.

ccix In the District Court of the United States for the District of Montana.

MINERALS SEPARATION, LIMITED; MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Petition for Appeal and Allowance.

To the Honorable George M. Bourquin, Judge of the District Court of the United States for the District of Montana:

The above-named defendant, Butte and Superior Mining Company, formerly Butte and Superior Copper Company, Limited, con-

sidering itself aggrieved by the decree entered in the above styled court on the 17th day of September, 1917, in the above styled
cex cause and particularly by that part of said decree which adjudges United States Patent No. 835,120 as good and valid in law as to claims 1, 2, 3, 5, 6, 7 and 12, and as to claims 9, 10 and 11, limited by the disclaimer, filed in the United States Patent Office and adjudges that the grantees of each of said patents are the true, original, first and joint inventors of the invention described in said patent, and particularly pointed out in the claims thereof above referred to and adjudges that the plaintiffs are the full and exclusive owners of said Letters Patent, and adjudges that the process employed by the defendant both before and after the filing of the bill of complaint and to and including January 7th, 1917, embodied the invention of said Patent No. 835,120, and infringed claims 1, 2, 3, 5, 6, 7 and 12, thereof, and claims 9, 10 and 11 as limited by said disclaimer, and adjudges that the process employed by the defendant from the 7th day of January, 1917, down to and through the day of trial embodied the invention of the patent in suit and infringed claims 1, 2, 3, 5, 6, 7 and 12 thereof, and claims 9, 10 and 11 as limited by the aforesaid disclaimer, and adjudges that the said defendant has infringed said patent and the claims thereof mentioned, and as decrees that a perpetual injunction issue enjoining the defendant, Butte and Superior Mining Company, its officers, associates, etc., from the use or installation in any manner of the alleged patented invention, or particularly claims 1, 2, 3, 5, 6, 7 and 12 thereof, or claims 9, 10 and 11 as limited by said alleged disclaimer, and as decrees that the plaintiff shall recover of defendant
cexi the profits which the defendant has derived, received or made by reason of said infringement, and shall recover any damages sustained by plaintiffs by reason of said infringement, and shall recover any costs in this suit to be taxed, hereby appeals from the said decree as specified to the United States Circuit Court of Appeals, for the Ninth Circuit, and prays that its appeal may be allowed and that a citation may issue as provided by law directed to the above-named plaintiffs, and each of them, commanding said plaintiffs, and each of them, to appear before the United States Circuit Court of Appeals, for the Ninth Circuit, to do and receive what may appertain to justice to be done in the premises; and that a duly authenticated transcript of the record and proceedings upon which said decree was made together with the accompanying assignment of errors be transmitted with this appeal to the United States Circuit Court of Appeals, for the Ninth Circuit.

Your petitioner further prays that a proper order touching the security to be required in order to perfect its appeal be made and a suitable bond be fixed by the court.

THOS. F. SHERIDAN,
J. EDGAR BULL,
J. BRUCE KREMER,
Solicitors for Defendant.

cexii The foregoing petition is hereby granted and the appeal is allowed in the above styled cause upon the defendant filing

a bond in the sum of $10,000.00, with sufficient surety or sureties to be conditioned as required by law.

GEO. M. BOURQUIN,
Judge of the District Court of the United States for the District of Montana.

Service of the foregoing petition for appeal and allowance acknowledged and copy thereof received this 20th day of September, 1917.

HENRY D. WILLIAMS,
W. H. KENYON,
LINDLEY M. GARRISON,
O. W. McCONNELL,
Solicitors for Plaintiffs.

Filed Sept. 20, 1917. Geo. W. Sproule, Clerk.

ccxiii In the District Court of the United States for the District of Montana.

MINERALS SEPARATION, LIMITED; MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Bond on Appeal.

Know all men by these presents:

That we, Butte and Superior Mining Company, formerly Butte and Superior Copper Company, Limited, as principal, and Western Accident and Indemnity Company, a corporation, organized and existing under and by virtue of the laws of Montana, as surety,

ccxiv are held and firmly bound unto the Minerals Separation, Limited, Minerals Separation American Syndicate, Limited, and Minerals Separation North American Corporation, in the sum of Ten Thousand ($10,000.00) Dollars, for the payment of which well and truly to be made, we bind ourselves jointly and severally, and each of our successors and assigns, firmly by these presents.

Sealed with our seals and dated this 20th day of September, 1917.

Whereas, the above-named defendant, to-wit: the principal in this obligation, has prosecuted an appeal to the United States Circuit Court of Appeals, for the Ninth Circuit, to reverse a decree made and entered in said cause on the 17th day of September, 1917, in favor of the said plaintiffs:

Now, therefore, the condition of this obligation is such that if the said defendant shall prosecute its said appeal to effect and answer all damages and costs if it fails to make its plea good and if the said decree be affirmed by the said United States Circuit Court of Appeals or by the Supreme Court of the United States, then the above obligation to be void, otherwise to remain in full force and virtue.

It is expressly agreed by the Western Accident and Indemnity Company, the surety above-named, that in case of a breach of any

condition of this bond the court may, upon notice of not less than ten (10) days to said Western Accident and Indemnity Company, proceed summarily in this action to ascertain the amount which said surety is bound to pay on account of such breach, and render
ccxv judgment against the said Western Accident and Indemnity Company, and award execution therefor.

WESTERN ACCIDENT AND INDEMNITY COMPANY,
By H. W. COOK, *President.*

Attest:
[SEAL.] WM. C. TUCKER, *Secretary.*

BUTTE AND SUPERIOR MINING COMPANY,
By J. BRUCE KREMER, *Attorney and Agent.*

The foregoing bond on appeal is hereby approved this 20th day of September, 1917.
GEO. M. BOURQUIN,
Judge of the District Court of the United States for the District of Montana.

Service of the foregoing bond on appeal acknowledged, approved and copy thereof received this 20th day of September, 1917.
HENRY D. WILLIAMS,
W. H. KENYON,
LINDLEY M. GARRISON,
O. W. McCONNELL,
Solicitors for Plaintiffs.

Filed Sept. 20, 1917. Geo. W. Sproule, Clerk.

ccxvi In the District Court of the United States for the District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Citation on Appeal.

The President of the United States to Minerals Separation, Limited, a Corporation; Minerals Separation American Syndicate, Limited, a Corporation, and Minerals Separation North American Corporation, a Corporation, and to Henry D. Williams, Esq., Lindley M. Garrison, Esq., William Houston Kenyon, Esq., and Odell W. McConnell, Esq., their solicitors:

You are hereby cited and admonished to be and appear
ccxvii before the United States Circuit Court of Appeals for the Ninth Circuit at the City of San Francisco, State of Cali-

fornia, within thirty (30) days from the date hereof pursuant to an appeal filed in the office of the Clerk of the District Court of the United States for the District of Montana, wherein Butte and Superior Mining Company, designated as Butte and Superior Copper Company, Limited, a corporation, in the above styled cause is the appellant and Minerals Separation, Limited, Minerals Separation American Syndicate, Limited, and Minerals Separation North American Corporation, are appellees, to show cause, if any there be, why the said decree in the said appeal mentioned should not be corrected and why speedy justice should not be done to the parties in that behalf.

Witness the Honorable, George M. Bourquin, Judge of the United States District Court, for the District of Montana, this 17th day of September, A. D. 1917, and of the Independence of the United States, the one hundred and forty-second, at the City of Butte, State of Montana.

GEO. M. BOURQUIN,
Judge of the District Court of the United States for the District of Montana.

ccxviii Service of the foregoing citation on appeal acknowledged and copy thereof received this 20th day of September, A. D. 1917.

HENRY D. WILLIAMS,
W. H. KENYON,
LINDLEY M. GARRISON,
O. W. McCONNELL,
Solicitors for Plaintiffs.

Filed Sept. 20th, 1917. Geo. W. Sproule, Clerk.

ccxix In the District Court of the United States for the District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Præcipe for Making up Transcript to George W. Sproule, Clerk of United States District Court, District of Montana.

Please prepare transcript of the record of this case for appeal to the United States Circuit Court of Appeals for the Ninth Circuit, and incorporating therein, omitting endorsements, viz:

ccxx Bill of complaint.
Subpœna in equity with return.
Answer filed October 28th, 1913.
Supplemental answer filed March 27th, 1917.
Answer filed April 17th, 1917.

Amendment to answer filed April 17th, 1917.
Supplemental and amended bill of complaint filed May 1st, 1917.
Answer to plaintiffs' supplemental bill of complaint.
Answer to plaintiffs' bill of complaint as amended.
Stipulations with reference to preparation of record.
Final record in the case.
Statement of the case for record on appeal, including all testimony, rulings of the court and proceedings during the trial of the case embodying full testimony in said case.
All exhibits in said case submitted by both plaintiffs and defendant introduced during the trial. All physical exhibits to be forwarded to the United States Circuit Court of Appeals for the Ninth Circuit as part of the record.

Opinion of the court.
Decree.
Petition for appeal.
Assignment of errors.
Order allowing appeal.
Order suspending injunction.
Bond suspending injunction.
Bond on appeal.
Stipulation for making up transcript of record on appeal.

cexxi All orders relative to appeal, preparation and filing thereof.
Præcipe for transcript.
Clerk's certificate.

Respectfully,

THOS. F. SHERIDAN,
J. EDGAR BULL,
J. BRUCE KREMER,
Solicitors for Defendant.

Service accepted Sept. 20, 1917.
HENRY D. WILLIAMS,
W. H. KENYON,
LINDLEY M. GARRISON,
O. W. McCONNELL, *Solicitors for Plaintiffs.*

Filed Sept. 20, 1917. Geo. W. Sproule, Clerk.

cexxii In the District Court of the United States for the District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Stipulation.

It is hereby stipulated and agreed by and between the parties hereto that the transcribed record of the testimony herein may be by the court approved and settled as the statement of the evidence and proceedings herein upon presentation of the same to the court, the said statement as hereinbefore stipulated to be in the next exact form

taken down and transcribed by the reporters at the time of the hearing of the said case and to include copies of the exhibits
cexxiii in said case, save physical exhibits, and it is stipulated that the court may settle the said statement upon presentation, it being understood that if any error is made in the statement to be presented to the court, the same shall be corrected by application to the court after settlement, if it is apparent to the court that error has been made in the transcribing, copying or printing of the said record, it being the intention hereof that the statement on appeal shall conform to the record made by the stenographers and reporters during the trial errors excepted.

It is further stipulated that the statement presented may be signed and settled by the court without further notice or hearing.

Dated this 17th day of September, 1917.

HENRY D. WILLIAMS,
WILLIAM H. KENYON,
ODELL W. McCONNELL,
Solicitors for Plaintiffs.
THOS. T. SHERIDAN,
J. EDGAR BULL,
J. BRUCE KREMER,
Solicitors for Defendant.

Approved:
BOURQUIN, *J.*

Filed Sept. 20, 1917. Geo. W. Sproule, Clerk.

cexxiv In the District Court of the United States for the District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Order.

It is hereby ordered, that after the filing of the petition for allowance of appeal and the procuring of the order allowing appeal and the filing of the assignment of errors and the giving of bond on appeal, the defendant may have to and including the 1st day of November, 1917, in which to file statement of the evidence and proceedings to be a part of the record on appeal, the same to be then submitted for the approval of this court as the statement of
cexxv the evidence and proceedings on appeal and its præcipe indicating the portions of the record to be incorporated into the transcript on such appeal, said præcipe to include statement so to be settled by the court.

Dated this 20th day of September, 1917.

GEO. W. BOURQUIN,
Judge of the District Court of the United States for the District of Montana.

Consented to this 20th day of September, 1917.
HENRY D. WILLIAMS,
WILLIAM H. KENYON,
LINDLEY M. GARRISON,
ODELL W. McCONNELL,
Solicitors for Plaintiffs.

Filed Sept. 20, 1917. Geo. W. Sproule, Clerk.

ccxxvi In the District Court of the United States for the District of Montana.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Order of Transmission of Physical Exhibits to Federal Court.

And now, on this 20th day of September, 1917, on the application of defendant's solicitor,

It is Ordered by the court that the physical exhibits in the above styled cause may be by the Clerk removed from the records of this court and transmitted to the Clerk of the United States Circuit Court of Appeals, for the Ninth Circuit, to be used upon the hearing of the appeal in that court. GEO. M. BOURQUIN, *Judge.*

Filed Sept. 20, 1917. Geo. W. Sproule, Clerk.

ccxxvii In the District Court of the United States for the District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE AND SUPERIOR MINING COMPANY, Formerly Butte and Superior Copper Company, Limited, Defendant.

Order Extending Time for Filing Record and Docketing Case.

For good cause shown, it is hereby ordered that the defendant may have to and including the 17th day of November, 1917, within which to file the record on appeal in the above styled case in the United States Circuit Court of Appeals for the Ninth Cir-
ccxxviii cuit, and the time for so filing said record and docketing said cause is hereby extended to that time.

Dated this 20th day of September, 1917.

GEO. M. BOURQUIN,
Judge of the District Court of the United States for the District of Montana.

Approved:
HENRY D. WILLIAMS,
ODELL W. McCONNELL,
For Plaintiffs.

Filed Sept. 20, 1917. Geo. W. Sproule, Clerk.

cexxix In the District Court of the United States for the District of Montana.

MINERALS SEPARATION, LIMITED, MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, and Minerals Separation North American Corporation, Plaintiffs,

vs.

BUTTE & SUPERIOR COPPER COMPANY, Defendant.

Stipulation.

It is hereby stipulated and agreed by and between the parties hereto that in the preparation of a statement of the case to be settled by the court and in preparation of the record on appeal herein, the full testimony of the witnesses in question and answer form shall be embodied in said record on appeal instead of a narrated statement of all the testimony, or a portion thereof, and that in the preparation of a statement herein the full record of the testimony in question and answer form shall be embodied in said statement in lieu of narrated testimony and that the full proceedings herein as taken down by the official stenographer during the course of the trial shall
cexxx constitute the record upon the statement of the case and shall constitute that portion of the record on appeal from any judgment, order or decree rendered in the above cause.

This stipulation is made in the light of the technical features of the case and in the light of the various questions arising from the testimony and this stipulation is further made subject to the consent of the judge of the above entitled court.

Dated this 16th day of May, 1917.

THOMAS F. SHERIDAN,
W. A. SCOTT,
J. BRUCE KREMER,
L. P. SANDERS,
ALF. C. KREMER,
Attorneys for Defendant.
ODELL W. McCONNELL,
HENRY D. WILLIAMS,
WILLIAM H. KENYON,
LINDLEY M. GARRISON,
Attorneys for Plaintiffs.

Consented and agreed to.
BOURQUIN, *Judge.*

Filed May 17, 1917. Geo. W. Sproule, Clerk, by H. H. Walker, Deputy.

a United States Circuit Court of Appeals for the Ninth Circuit.

No. 3081.

BUTTE AND SUPERIOR MINING COMPANY, Designated as Butte and Superior Copper Company, Limited, a Corporation, Appellant,

vs.

MINERALS SEPARATION, LIMITED, a Corporation; MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, a Corporation, and Minerals Separation North American, a Corporation, Appellees.

Substituted Pursuant to Order Filed March 19, 1918, for Incorrect Copy Filed November 10, 1917.

TRANSCRIPT OF RECORD.

Volume 2.

(Pages 1 to 656, Inclusive.)

Upon Appeal from the United States District Court for the District of Montana.

Filed Mar. 19, 1918. F. D. Monckton, Clerk.

1 In the District Court of the United States for the District of Montana.

No. 8.

MINERALS SEPARATION, LTD.,

vs.

BUTTE & SUPERIOR COPPER CO., LTD.

This cause came on regularly for hearing at this time upon motion of plaintiff to show cause why an injunction pendente lite should not issue herein, Henry D. Williams, Esq., and O. W. McConnell, Esq., appearing as solicitors for plaintiff, and W. Scott, Esq., and J. B. Kremer, Esq., as solicitors for defendant. And thereupon plaintiff offered the pleadings in the suit of Minerals Separation, Ltd., and another against James M. Hyde on the return of this order to show cause, in evidence. Defendant objects to the offer of the record upon the order to show cause but consents that if it is the desire of plaintiff to get this whole record before the Court, that it might be admitted for all purposes in this case. Plaintiff offers the entire record.

Defendant: We object to the offer of that record in this
2-15 case upon the order to show cause, but if it is the purpose of offering the record in this case in its entirety for use, both now and upon final hearing, we will consent to it.

Plaintiff: I am quite willing to broaden my offer to that extent.

The Court: Let the record show the offer.

Plaintiff: As fully as if the witnesses were present and testifying in the case.

The Court: The Court so understands it.

Entered in open court November 4, 1913.

GEO. W. SPROULE, *Clerk.*

16 *Complainants' Record.*

Volume I.

17 *Bill of Complaint.*

United States Circuit Court, District of Montana, Northern Division.

In Equity.

MINERALS SEPARATION, LIMITED, and MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, Complainants,

vs.

JAMES M. HYDE, Defendant.

To the Honorable the Judges of the Circuit Court of the United States in and for the District of Montana, Northern Division:

Minerals Separation, Limited, a corporation duly organized and existing under and by virtue of the laws of Great Britain, and an inhabitant of Great Britain and having its principal office in London, England, and Minerals Separation American Syndicate, Limited, also a corporation duly organized and existing under the laws of Great Britain, and an inhabitant of Great Britain, also having its principal office in London, England, bring this their bill against James M. Hyde, of Basin, Jefferson County, State of Montana, a resident of the State of Montana and an inhabitant of the Northern Division of the District of Montana; and thereupon your orators complain and say:

18 First. That heretofore and before the 29th day of May, 1905, Henry Livingston Sulman, Hugh Fitzalis Kirkpatrick-Picard, and John Ballot, all of London, England, did invent and were the original, first and joint inventors of certain new and useful improvements in Ore Concentration fully described in the Letters Patent hereinafter mentioned, which invention had not been known or used in the United States before their invention or discovery thereof, or patented or described in any printed publication in any

country before their invention or discovery thereof or more than two years prior to their application for letters patent of the United States, hereinafter mentioned, or in public use or on sale in the United States for more than two years prior to their said application, and had not been patented in any country foreign to the United States on an application filed by them or their legal representatives or assigns more than twelve months prior to the filing of their said application for Letters Patent of the United States, and had not been abandoned to the public; that the said Henry Livingston Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, being as aforesaid the joint inventors of the said invention, did on the 29th day of May, 1905, make due and formal application to the Commissioner of Patents of the United States for Letters Patent of the United States therefor, in accordance with the then existing laws of the United States, and duly complied in all respects with the
19 conditions and requirements of said laws; and thereafter, after due proceedings had, on the 6th day of November, 1906, Letters Patent of the United States numbered 835,120, signed by the Assistant Secretary of the Interior and countersigned by the Commissioner of Patents and sealed with the seal of the Patent Office, all in due form of the law and bearing date the day and year last aforesaid, were duly issued and delivered to the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, whereby was secured to them, their executors, administrators and assigns, for the term of seventeen years from the 6th day of November, 1906, the full and exclusive right of making, using and selling the said improvements in Ore Concentration shown, described and claimed in said Letters Patent, throughout the United States and the territories thereof, which Letters Patent are now on record in the United States Patent Office, and which, or a duly certified copy thereof, your orators will produce as your Honors may direct.

Second. And your orators further show unto your Honors that on or about the 7th day of December, 1909, the said Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot, by an instrument in writing duly executed and delivered by them and bearing date the last named day, assigned and transferred to your orator, Minerals Separation, Limited, all right, title and
20 interest in and to the said invention and Letters Patent, and that the said instrument in writing was duly recorded in the Patent Office of the United States on or about the 28th day of August, 1911, all of which will more fully appear by the said instrument in writing with the certificate of the Commissioner of Patents ready in court to be produced as your Honors may direct.

Third. And your orators further show unto your Honors that on or about the 10th day of October, 1910, by an instrument in writing duly executed and delivered and bearing date the last named day, your orator, Minerals Separation, Limited, granted unto your orator, Minerals Separation American Syndicate, Limited, and your orator, Minerals Separation American Syndicate Limited, received and accepted the sole and exclusive right, license, power and authority to apply, use and exercise in the United States of America the

invention described in the said Letters Patent No. 835,120 for the term of two years from the said 10th day of October, 1910, together with the option to purchase said Letters Patent during said term of two years, all of which will more fully appear by the said instrument in writing ready in court to be produced as your Honors may direct.

Fourth. And your orators further show unto your Honors that by virtue of the premises your orators became, and now are,
21 the sole owners of all right, title and interest in and to the said Letters Patent and the said invention covered thereby, and all rights therein and thereunder within and throughout the United States, and your orators show that the rights and privileges secured by the said Letters Patent have been generally acquiesced in throughout the United States excepting in the instance of this defendant and his confederates, and that the said invention described in said Letters Patent is of great value and utility to your orators and the public generally, and that your orators have made the said invention profitable to themselves and to the public by careful and elaborate tests of said invention in its application to a wide variety of ores and by extensive commercial use of the said invention in different parts of the world, and by numerous demonstrations of the utility of said invention in the treatment of ores that are mined and treated in the United States, and that your orators have made and are making great efforts toward the introduction of said invention into extensive commercial use in the United States; and that your orators have invested large sums of money in said invention in the demonstrations thereof and the efforts to introduce the same into commercial use in the United States and in making the same valuable to the public and to themselves, and that your orators are able and willing to supply the entire demand for the use of the said invention throughout the United States, and that your orators will realize and receive large gains and profits from the said in-
22 vention if infringement by the defendant and his confederates shall be prevented.

Fifth. And your orators further show unto your Honors that prior to the date of the infringement herein complained of, the defendant, James M. Hyde, had been for a period of about one year in the employment of your orator, Minerals Separation, Limited, such employment having terminated on or about February 1, 1911; that the defendant, when thus employed, was instructed by the engineers and experts of your said orator in all technical details and particulars as to the said Letters Patent No. 835,120, and the installation and use of the process of ore concentration constituting said invention; and your orators further show that the usual manner of conducting the business of using the said invention is the installation of proper apparatus and the granting of licenses for using said invention conditioned on the payment of royalties measured by the output of the said process of ore concentration.

Sixth. And your orators further show unto your Honors, that the defendant, well knowing the premises and the rights secured to your orators as aforesaid, and contriving to injure your orators and to deprive them of the benefits and advantages from said invention

and Letters Patent, did, after the issuance of said Letters Patent and since the termination of the employment of the defendant
23 by your orators, Minerals Separation, Limited, as aforesaid, and before the commencement of this suit, as your orators are informed and believe, without the license or allowance, and against the will of your orators, and in violation of their rights and in infringement of the aforesaid Letters Patent No. 835,120, unlawfully and wrongfully, and in defiance of the rights of your orators, at the town of Basin, in the County of Jefferson, State of Montana, and within the Northern Division of the District of Montana, where the defendant has a regular and established place of business, and elsewhere in the United States, install apparatus for and carry on the use of the said process of ore concentration set forth and claimed in the aforesaid Letters Patent No. 835,120, and confederated with others in such installation and use, and is threatening to further induce others to make such installation and use, all in infringement of your orators' rights under the said Letters Patent whereby your orators have been and still are being deprived of great gains and profits that they might and otherwise would have obtained, and which have been realized and enjoyed by the said defendant by and through his aforesaid unlawful acts and doings.

Seventh. And your orators further show unto your Honors, on information and belief, that the said defendant has made and received, and is making and receiving large profits and advantages from
24 the infringement of the said Letters Patent as aforesaid, but to what extent and how much exactly your orators do not know, and pray a discovery thereof.

Eighth. And your orators further show unto your Honors that the installation and use of the said invention by the said defendant and his other unlawful acts in this regard in defiance of the rights of your orators, have the effect of aiding, encouraging and inducing others so to venture to infringe said Letters Patent in disregard of your orators' rights.

Ninth. And your orators further show unto your Honors that they have caused notice to be given to the said defendant of the said infringement of the rights of your orators in the premises and have requested him to desist and refrain therefrom, but the said defendant has disregarded such notices and refuses to desist from said infringement, and has continued after such notice in the infringement of your orators' rights as aforesaid.

And inasmuch as your orators cannot have any adequate relief except in this Court, and to the end that the defendant may, if he can, show cause why your orators should not have the relief herein prayed for, and may, but not upon oath (an oath to the defendant's answer being hereby waived) according to his best and utmost knowledge, remembrance, information and belief, full, true, direct and perfect answers make to all and singular the premises, and
25 that the said defendant may be compelled to account for and pay to your orators the profits thus unlawfully derived, or which might have been derived from the violation of the rights of your orators as aforesaid, as well as the damages therefor, and be

restrained from any further violation of said rights, your orators pray that your Honors may grant a writ of injunction restraining the defendant, his confederates, associates, servants, agents, attorneys, clerks and workmen, and every person acting for or on behalf of said defendant, from any installation or use in any manner of the said patented invention or any part thereof, in violation of the rights of your orators as aforesaid, and from encouraging and inducing others to infringe the said Letters Patent and from defending other infringers of said Letters Patent or reimbursing them the expense of defending against said Letters Patent in whole or in part, or otherwise aiding or abetting others to install or use processes of ore concentration in infringement of said Letters Patent; and also that your Honors, upon the entering of a decree for infringement, as above prayed for, may proceed to assess or cause to be assessed, under your Honors' direction, in addition to the gains or profits to be accounted for by the defendant, the damages your orators have sustained by reason of said infringement, and that the amount of said damages may, in view of the wanton character of the infringement committed, be increased to a sum not exceeding three times the amount thereof.

26 And your orators pray also for a provisional or preliminary injunction during the pendency of this suit to the same purport and effect as hereinbefore prayed in regard to a perpetual injunction, and that the said defendant may be decreed to pay the costs of this suit; and for such further and other relief as the equity of the case may require, and as to your Honors may seem meet.

May it please your Honors to grant unto your orators a writ of injunction conformable to the prayer of this bill, and also a writ of subpœna issuing out of and under the seal of this Honorable Court directed to the said defendant James M. Hyde commanding him by a certain day and under a certain penalty to appear before this Honorable Court, then and there to answer the premises, and to abide by and perform such orders and decrees in the premises as to the Court shall seem meet, and be required by the principles of equity and good conscience.

And your orators will ever pray, etc.

MINERALS SEPARATION, LTD.,
By S. GREGORY, *Director.*
MINERALS SEPARATION AMERICAN SYNDICATE, LTD.,
By S. GREGORY, *Director.*
McCONNELL & McCONNELL,
Solicitors for Complainants.

HENRY D. WILLIAMS,
Of Counsel.

27 UNITED STATES OF AMERICA,
State of New York,
County of New York, ss:

Seth Gregory, being duly sworn, deposes and says that he is a director of Minerals Separation, Limited, one of the complainants named in the foregoing bill of complaint, and that he is also a director of Minerals Separation American Syndicate, Limited, the other complainant named in the foregoing bill of complaint; that he has read the same and knows the contents thereof, and that the same is true of his own knowledge, except as to the matters therein alleged on information and belief, and as to those matters he believes it to be true; and that he verily believes that Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard and John Ballot were the true, first, original and joint inventors of the invention set forth and claimed in the Letters Patent referred to in the bill of complaint.

SETH GREGORY.

Subscribed and sworn to before me this 29th day of September, 1911.

[SEAL.] BERNARD COWEN,
Notary Public, New York County.

Filed October 9, 1911.

Replication.

(In usual form filed December 30, 1911.)

28 United States District Court, District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, and MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, Complainants,

vs.

JAMES M. HYDE, Defendant.

The depositions of the witnesses in behalf of complainants in the above entitled suit, taken by agreement of counsel before Bernard Cowen, Esq., a Notary Public, in and for the County of New York and State of New York, acting by consent of counsel for both parties as Special Examiner under the 67th Rule in Equity as amended, at the office of Henry D. Williams, 76 William Street, Borough of Manhattan (County of New York), in the City and State of New York, beginning on Thursday, February 15, 1912, at eleven o'clock in the forenoon.

Appearances:

Henry D. Williams, Esq., for Complainants.
J. Bruce Kremer, Esq., and Walter A. Scott, Esq., for Defendant.

It is stipulated that Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, the complainants, are corporations duly organized and existing under the laws of Great Britain and are inhabitants of Great Britain, having their principal offices in London, England.

Counsel for complainants produces the patent in suit, No. 835,120, granted November 6, 1906, and also a certified copy thereof, and it is stipulated that the said certified copy may be offered in evidence with the same force and effect as the original letters patent. The said certified copy is offered in evidence as "Complainants' Exhibit, Patent in Suit."

Counsel for complainants produces an acknowledged assignment from the patentees, Henry Livingstone Sulman, Hugh Fitzalis Kirkpatrick-Picard, and John Ballot, to Minerals Separation, Limited, dated December 7, 1909, and also a copy thereof, and it is stipulated that the copy may be offered in evidence with the same force and effect as the original assignment, subject, however, to the production of the original upon request. The said copy is offered in evidence and marked "Complainants' Exhibit, Assignment."

Counsel for complainants produces an agreement bearing date October 10, 1910, between Minerals Separation, Limited, and Minerals Separation American Syndicate, Limited, the same having been acknowledged, and also a copy thereof, and it is stipulated that the copy may be offered in evidence with the same force and effect as the original agreement, subject, however, to the production of the original upon request. The said copy is offered in evidence and marked "Complainants' Exhibit, License Agreement."

Counsel for complainants offers in evidence a certified abstract of title of the patent in suit and it is marked "Complainants' Exhibit, Abstract of Title."

It is stipulated that printed Patent Office copies of the specifications and drawings of Letters Patent of the United States and Great Britain may be introduced and shall be received in evidence with the same force and effect as original Letters Patent or duly certified copies thereof, as to all the facts set forth in said printed copies, including the dates of filing of the applications for said Letters Patent and the issuance thereof, subject to correction by other proof.

It is stipulated that statements in the printed Official Journal of the British Patent Office as to the sealing dates of British patents shall be accepted as prima facie proof thereof, subject to correction by other proof.

It is stipulated that original depositions and exhibits introduced in connection with this suit may be delivered to and remain in the custody of counsel for the party taking said deposition, to be filed in Court at or before the hearing, subject to the examination and

proper use of any depositions or exhibits by opposing counsel on reasonable notice.

31 EDWARD H. NUTTER, a witness produced in behalf of complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. Please state your name, age, residence and occupation.

A. Edward Hoit Nutter; age, thirty-six; residence, Berkeley, California; I am a mining engineer and metallurgist.

2 Q. By whom are you employed and in what capacity?

A. I am employed by Minerals Separation American Syndicate, Limited, one of the complainants, as their Chief Engineer.

3 Q. Immediately prior to that employment, by whom and in what capacity were you employed?

A. I was employed by Minerals Separation, Limited, the other complainant, as an Engineer.

4 Q. Please state your education in mining engineering and briefly your experience therein prior to your employment by either of the complainants.

A. I am a graduate of Leland Stanford, Jr., University, in geology and mining, and hold the degree of Bachelor of Arts. Since my graduation, I have been employed in various capacities in mines and reduction works in different parts of the West, usually in a position of some responsibility. In 1904, I was appointed
32 Assistant Superintendent of the Standard Consolidated Gold Mining Company, operating a mine at Bodie, California; in 1906, I was appointed Superintendent of the Company, which position I resigned in 1906, to become Assistant General Superintendent of the Liberty Bell Gold Mining Company, operating a mine and reduction works at Telluride, Colorado. In 1907, I was appointed Superintendent of this mine and reduction works. I resigned this position, my resignation taking effect in 1909, after which I made a trip through western Alaska, examining mining properties there. After my return from Alaska, I was not further employed until I became employed by Minerals Separation, Limited, in February, 1910.

5 Q. Since entering the employ of the complainant Minerals Separation, Limited, in February, 1910, what experience have you had in connection with the oil flotation concentration processes of that company and the other complainant?

A. I was in Great Britain for about two weeks immediately after my employment by the Minerals Separation, Limited, and studied their process and was instructed as to the nature of their process up to the time that I left for Australia. Early in March, I went to Australia and examined and studied reduction works in which the processes of Minerals Separation, Limited, were being used. I left Australia early in June, reaching London about five weeks later,

and from then on until the middle of February, 1911, I was studying and had a certain amount of supervision of the conduct
33 of tests in Minerals Separation, Limited, testing works in London. About the middle of February, 1911, I came to the United States and have been engaged since then in testing ores or supervising the tests on ores by the processes of Minerals Separation, Limited, and in inspecting mining property in connection therewith.

6 Q. Do you know the defendant, James M. Hyde, and, if so, how long have you known him?

A. Yes. I have known him about twelve years.

7 Q. During the period of your employment by the complainants did you meet the defendant, Mr. Hyde, and, if so, under what circumstances?

A. Yes. When I first reached London on becoming employed by Minerals Separation, Limited, I found that Mr. Hyde had also been employed by them and had preceded me to London by a few days. Until I left for Australia, Mr. Hyde and I were together a number of times at the Company's office in London, and elsewhere in London, and in South Wales, where a small concentration plant operating the Company's processes was running. After I returned from Australia I did not see Mr. Hyde again until in December, 1910, when he was again in London and where we met frequently.

8 Q. So far as you know, what opportunities were afforded to the defendant, Mr. Hyde, to become familiar with the concentration processes of Minerals Separation, Limited?

34 Mr. Kremer: Defendant objects for the reason that the testimony is incompetent, irrelevant and immaterial, and has no bearing upon the issues of this case, neither proving nor tending to prove the alleged cause of action set out in the bill; and further, for the reason that the witness has not shown what knowledge he has of Mr. Hyde's acts and the question calls for a conclusion. Defendant further objects for the reason that it has not been shown of what the alleged concentration processes referred to as belonging to Minerals Separation, Limited, consists. This objection will be continued without repetition to all questions along this line, by agreement of counsel.

A. So far as I know, Mr. Hyde was instructed by the Minerals Separation, Limited's, consulting engineer, Mr. Theodore J. Hoover, as to the nature of the Company's processes, and was afforded every means possible to study these processes in the testing works in London and South Wales, prior to the time that I left for Australia. This instruction consisted of information furnished to Mr. Hyde and myself by Mr. Theodore J. Hoover and of inspection of the testing works in operation in South Wales.

On and after Mr. Hyde's arrival in London in December, 1910, he was afforded every opportunity to inspect and study the Company's testing works in London and did so inspect and study them.

35 9 Q. Did you have any conversations with Mr. Hyde wherein he stated to you his plans in relation to the Company's affairs?

A. Yes.

10 Q. What, in general, was the substance of these conversations relative to his intentions as to knowledge of and use of the processes of the complainant?

Mr. Kremer: Defendant objects to the question last propounded for the reason that it is indefinite, it being nowhere stated of what the alleged processes consist.

A. We had a great many conversations on this general topic, which would make it rather difficult for me to answer.

11 Q. Please state the substance of any conversation with the defendant Hyde after he had entered the employ of Minerals Separation, Limited, wherein mention was made of the length of his employment, the motives that had controlled him in entering their employ for that period, and his plans as to what he would do after leaving their employment, if there was any such conversation.

Mr. Kremer: Defendant objects for the reasons embodied in the preceding objection, and for the further reason that the question is decidedly leading.

36 A. Mr. Hyde and I had conversations, wherein Mr. Hyde stated in substance that he had accepted employment by Minerals Separation, Limited, for a year only, so that he would be free at the end of that period to make a more favorable contract with the Company for his further services, or else to make use of his knowledge of flotation concentration for his own purposes.

12 Q. Did you visit Basin, Montana, last summer and meet Mr. Hyde, the defendant, while there?

A. Yes.

13 Q. Please state the substance of the conversations between you and Mr. Hyde during that visit so far as they related to a concentration plant and obtaining knowledge thereof and impending suit for infringement, giving the dates and such general descriptions as will bring out the circumstances in general.

A. I went to Basin, Montana, early in August, 1911, and after my arrival there I visited the mill of the Basin Reduction Works (I think it is called), being operated for the treatment of ores by the Butte & Superior Copper Company, and Mr. Hyde was called and came up to the office where I was. I told Mr. Hyde the we knew that he was operating a flotation process plant, in infringement of my Company's patents, and I asked permission of him to see what he was doing, as we intended bringing suit against him and I thought it would be better all around if that suit should be made a friendly suit, and I therefore requested permission to visit and inspect the plant he was operating. Mr. Hyde refused this
37 request of mine and told me that under no circumstances would he allow me to see what he was doing.

14 Q. Was anything said between you and Mr. Hyde as to the ownership or the contracts for the building of the plant which you asked permission to see, and if so, what?

Mr. Kremer: Defendant objects for the reason that the matter sought to be elicited is incompetent, irrelevant and immaterial and neither tends to prove nor disprove any issue in the case.

A. Mr. Hyde referred to the flotation plant as his plant, and told me in substance that he had laid the patent situation completely and fully before the Butte & Superior Copper Company, with reference to flotation concentration, and that they had gone ahead with their eyes open and had entered into a contract with him to instal for them a flotation concentration plant. He told me that he had installed an Everson-Froment process plant with his own modifications. I told him I thought that this was a subterfuge on his part, as we knew what he was doing.

15 Q. Did you make another visit to this mill, and, if so, when, and please relate the circumstances?

A. Yes. Two days later. I went to Basin on a south-bound train, which arrived there in the evening. Between nine and
38 ten o'clock that evening, I went to the Butte & Superior Company's mill, where I reconnoitered for the purpose of locating exactly the flotation plant which Mr. Hyde was operating. I located it in an annex to the mill and observed what I could from the outside by looking through a window and cracks in the walls for a matter of an hour or more. I retired from the immediate neighborhood of the mill when the time came for changing shifts, which was a few minutes before and after eleven o'clock. After the shifts had changed, I again observed from the outside as well as I could what was going on about and what the appearance was in the flotation plant. I was able to observe some of the general features of the apparatus installed, and saw the men operating it. I observed where the workmen entered and left the room in which the flotation plant was operating and so I went around to that entrance and went in. The shift foreman came up to me immediately and objected to my presence there, but I engaged him in conversation, stepped up on a runway that was used by the workmen in operating the plant, looked the apparatus over, recognized it as being substantially the same and of about the same size and capacity as the flotation plant in the testing works of Minerals Separation, Limited, in London, and, so far as I could see, it was operating essentially in the same way.

39 Mr. Kremer: Defendant moves to strike out the last six lines of the testimony, for the reason that they embody conclusions of the witness, which are not of an expert character, there being no testimony in the record justifying such conclusions as there embraced.

(Answer continued:) The shift foreman continued to object to my presence. I had placed my hand in one of the froth separating boxes from which a concentrate froth was flowing into a launder, and noted

the feel of the concentrate and of the liquor in the frothing box. I had seen then practically all I cared to see, so I scooped a sample of the froth concentrate up in my hand and walked along the runway to the entrance, looking at the apparatus as I did so, and went out. The shift foreman asked me to wash my hands before going away, but I did not do so. I had a wide mouthed bottle in my pocket and as soon as I got outside, I transferred the concentrate from my hand into this bottle. I went around to the railroad track and walked toward the station. I heard someone following me and stopped and waited for him. It proved to be the shift foreman again, who asked me to surrender the sample of concentrate which I had taken, which I refused to do. He asked me to go with him to Mr. Hyde's house and tell Mr. Hyde what I had done, so that he would not be blamed. This I also refused to do.

40 Mr. Kremer: Defendant moves to strike out the testimony with reference to conversation had between the witness and the person referred to as the "shift foreman" on the ground that such testimony is hearsay, and, hence, incompetent.

(Answer continued:) I had previously engaged a room in a lodging house and I then went to it and to bed. The next morning I took the train for Helena, Montana, where I made up a package containing the sample of concentrate, which I had taken, and sent it by registered mail to Mr. Henry D. Williams, counsel for the complainants.

16 Q. Please state whether or not you recognize the two pieces of wrapping paper now handed to you, and if so, what they are.

A. Yes. These are the pieces of paper which I wrapped about the bottle containing the sample of concentrate and sent by registered mail to Mr. Williams. One is the outer wrapper, which carries the address to Mr. Williams and return address in my handwriting, and the post date, Helena, Montana, August 11, 1911, and a wax seal which was placed on the package by the registry clerk in the Helena Post Office, in my presence. The other is an inner wrapper, on which I had placed various marks to enable me to judge whether or not the package had been opened, should it be left for me to open it.

41 Mr. Williams: The two pieces of paper identified by the witness are offered in evidence and marked "Complainants' Exhibit, Outer Wrapper of Defendant's Concentrate" and "Complainants' Exhibit, Inner Wrapper of Defendant's Concentrate."

Mr. Kremer: To which offer defendant objects, for the reason that the papers have not been sufficiently identified to make them competent as exhibits, and for the further reason that their competency as exhibits in this action has not been established by proof tending to show that the bottle which the witness states was enclosed in the paper and the contents of the said bottle were in the same condition at the time of reaching the alleged destination as indicated by the address, as they were at the time of the alleged mailing.

17 Q. I call your attention to the written words on "Complainants' Exhibit, Outer Wrapper of Defendant's Concentrate," as follows: "Outer label of package opened by Dr. Charles F. Chandler, in the presence of Henry D. Williams and Oscar Spitzer, this 18th day of August, 1911. C. F. Chandler, Oscar Spitzer, Henry D. Williams." Was this upon the wrapper when you mailed it at Helena?

A. No.

18 Q. I call your attention to the written words on "Com-
42 plainants' Exhibit, Inner Wrapper of Defendant's Concentrate," as follows: "Opened by Dr. Charles F. Chandler in presence of Henry D. Williams and Oscar Spitzer this 18th day of August, 1911. Charles F. Chandler, Oscar Spitzer, Henry D. Williams." Was this upon this wrapper when you mailed it at Helena?

A. No.

19 Q. In other respects, except for the exhibit marks and the post marks and stamps, are these exhibits as they were when you mailed the package at Helena, except of course that now they are flat?

A. Yes.

20 Q. On what day did you inspect and examine this concentration plant at Basin, Montana, as you have testified?

A. In the evening of August 10, 1911.

21 Q. Was anything said to you by the shift foreman as to who employed him in his work? And if so, what?

Mr. Kremer: Defendant objects to any conversations had between the alleged shift foreman and the witness on the ground that such conversations would be hearsay and incompetent.

A. Yes. He said he was working for Mr. Hyde.

22 Q. Did you make drawings of what you saw at the concentration plant at Basin, and, if so, when did you make them?

43 A. Yes. I made sketch drawings from memory of what I had seen at Basin upon my return to Butte, Montana, from Helena, after I had mailed the concentrates sample to Mr. Williams, on the same day or possibly after midnight of that day.

23 Q. Please produce these drawings.

A. I now do so (witness produces two sheets of drawings).

24 Q. Please now, with these drawings before you, and referring to them, describe the concentration plant which you examined at Basin, Montana, as you have testified.

Mr. Kremer: Defendant objects for the reason that this testimony if given would be entirely without the issues of this case and would neither prove nor tend to prove any issue in the case.

A. The Sketch Plan is a drawing made from memory, showing approximately in plan, the arrangement of the flotation apparatus, as I observed it in the Butte and Superior mill at Basin, Montana. It indicates in their approximate relationship two flotation apparatus units. The Front Elevation shows the relationship of these units as seen from the front. The End Elevation shows in part the relationship between the different parts of either of these units.

These sketches were made entirely by myself and the letter-
44 ing and writing is all in my handwriting. The letters and numbers on the different sketches refer to the same details in the different views. The numbers 1 to 10 indicate the mixers or agitators. I am not certain that I have the number of these correctly given, as I did not count them, but I think there were about seven mixers in one unit and three in the other. The small script letters *a* to *g* indicate the frothing boxes or spitzkasten attached to and operating in conjunction with the mixers. I am not certain either as to the exact number of these, but there were approximately the number shown. B is a plank connecting the entrance to the flotation plant H with the main mill building. A is a launder, which I observed only from the outside and may not have indicated its position correctly. I is a small partly enclosed court, through which I passed to enter the flotation plant at H. G is a platform used by workmen in feeding material to the mixers. F is a runway, which was used by the workmen in operating the plant. E is a platform on approximately the same level as the tops of the frothing boxes, though I am not certain that it covered the whole space indicated; in fact, I think it did not. D is a launder, which received the flotation concentrate from frothing boxes *f* and *g*. C is a launder which received the flotation concentrate from frothing boxes *a* to *e*. The arrows in all cases indicate the direction of flow of the concentrates in the frothing boxes and in the launders. The flotation plant was in a room sand-
45 wiched or lying between another room which I have indicated in the Sketch Plan by the word "Shop," and other parts of the mill building which I cannot identify. J indicates a space between the end wall and the smaller flotation unit, but I am not sure that I have shown its relative area correctly. The word "Bench" indicates a work bench, which calls for no description. The word "Window" indicates an outer window, through which I looked, and the words "Slide Door" indicate such a door which had some pretty wide cracks in it. The word "Platform" indicates an outer platform leading to the door indicated.

In the operation of the plant as I observed it, the pulleys which are indicated near the figures 1 to 10 were being rotated by belts which came from the back of the mixers. They appeared to be rotating at the normal speed used in the Minerals Separation Company flotation plants of this size and approximate capacity, except that the one in mixer No. 8 was rotating faster. As I observed it, the pulp was being brought into the plant by workmen in buckets and wheel-barrows and fed into, I think, mixer No. 1. The concentrate froth from the larger unit was flowing into launder C from the frothing boxes, though one or two of them I noticed were not overflowing at the time of my visit. The concentrate froth from *f* and *g*, the frothing boxes of the smaller units, were flowing into the launder D, and the sample of froth which I took was from the lip of the frothing box *f* as it flowed into the launder D. The froth which was being formed and flowing into the launders was
46 the typical appearing agitation froth as made in plants using a Minerals Separation flotation froth process.

25 Q. You have mentioned in your answer the normal speed used in the Minerals Separation flotation plant of this size and approximate capacity. What is that normal speed, and what that approximate capacity?

A. In plants of this size, the mixer spindles are planned to rotate about 400 revolutions per minute, and these mixer spindles appeared to me to be rotating at a speed somewhere in the neighborhood of this. The capacity of such a plant on an ore of the Butte & Superior type should be about 40 or 50 tons per day.

26 Q. In flotation concentration plants of Minerals Separation such as you have referred to as of substantially the same construction as this plant, what substances or re-agents were used in connection with the ore and water to produce the froth of which you have spoken?

A. Usually oleic acid.

27 Q. In addition to the oleic acid, was there anything in solution with the water, and, if so, what?

A. There are what we call soluble re-agents used which give in general a similar appearing froth to that produced by the use of oleic acid, such as amyl alcohol or fusel oil, but when this is being used it unmistakably makes its presence known by its odor and I observed no such odor in the plant at Basin.

28 Q. What observations did you make as to the tempera-
47 ture of the water in any of the spitzkasten?

A. I held my hand for possibly a minute in the spitzkasten *f*, and noted the feel of the solution as to temperature. As soon as I had the opportunity, which was upon my return to Butte, I prepared a bowl of water until it felt to me to be of the same temperature as I recollected it, and then I measured the temperature with a Fahrenheit thermometer of this water so prepared. My results were from 102 to 105° Fahrenheit.

29 Q. Did you observe while in the plant any visual indications of the fact that the water used in the plant was heated, and, if so, what?

A. Yes. Steam vapor was arising from the surfaces of the spitzkasten and from the mixing boxes.

30 Q. Did you make any observations as to whether or not the water in the spitzkasten was acidified, and if so, what?

A. I made the indirect observation that, when I went to wash my hands in my room after having taken the sample of concentrate, that there was the sticky or gummy feel to my hands when I used soap, which feeling one usually experiences after wetting his hands with an acidulated solution.

31 Q. Is or is not the use of acidulated water characteristic of the Minerals Separation frothing processes to which you have referred?

A. Its use is characteristic on such ores as that of the Butte & Superior Company.

48 32 Q. And what acid is usually employed?

A. Sulphuric acid is nearly always employed.

33 Q. What, in general, has been your experience such as would justify your judgment of the speed of rotation of parts?

A. I have had to do with the operation of machinery a great deal and I am an electrical machinist by trade, and my work, when I was working as such electrician or electrical machinist, had to do a good deal with the measurement of speeds.

34 Q. What, in your opinion, based upon your knowledge of and experience with Minerals Separation flotation processes, was the function and utility of the smaller unit, the mixing boxes of which are marked in your Sketch Plan 8, 9, and 10, and the frothing boxes *f*, *g*?

A. My opinion is that this was a retreatment unit for retreating the concentrate from the larger apparatus for the purpose of cleaning it and raising the grade of the concentrate.

35 Q. What, in your opinion, was the function and utility of the three successive agitation boxes marked 1, 2 and 3, in their relation to the first frothing box marked *a*?

A. My opinion is that these were for the purpose of beating air into the ore pulp, such as is usually done in Minerals Separation process plants, and of agitating the ore pulp for the purpose of forming the concentrate froth which first appears in the initial spitzkasten *a*.

49 36 Q. And what, in your opinion, is the relationship between the first spitzkasten *a* and the mixing box 4?

A. My opinion is that the ore pulp, after having the initial froth removed, flows through a pipe to the mixing box 4, where it is again agitated and aerated for the purpose of forming a concentrate froth in the second frothing box *b*.

37 Q. And generally as to frothing box *b* and the mixing box 5, the frothing box *c* and the mixing box 6, the frothing box *d* and the mixing box 7, what, in your opinion, was the connection and relationship of these parts in their treatment of the ore pulp?

A. My opinion is that the arrangement was similar to that just described, and that the ore pulp flowed from each mixing box into the spitzkasten shown in the sketch directly in front of it, and that there was a pipe connection in the bottom of the spitzkasten to the next mixing box.

38 Q. Please briefly describe what, in your opinion, was the course of the ore pulp in the smaller unit.

A. My opinion is that the ore pulp, which, in this case, I believe to be the concentrate from the first set of frothing boxes, was fed into the mixer 8 and flowed from thence into the mixer 9, thence into frothing box *f*, where a froth concentrate was taken off, the remainder of the pulp flowing thence into mixing box 10, where it was again agitated, and thence into the frothing box *g*, where a froth was taken off.

50 Mr. Williams: Counsel for complainants offers in evidence the two drawings produced by the witness in answer to 23 Q and they are marked "Complainants' Exhibit, Nutter Drawing of

Defendant's Plant, Sheet 1" and "Complainants' Exhibit, Nutter drawing of Defendant's Plant, Sheet 2."

Direct examination closed.

Adjourned to Friday, February 16, 1912, at 10:30 A. M., at the same place.

New York, February 16, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Edward H. Nutter.

By Mr. Scott:

39 X Q. You have referred to certain processes, which you have called the "Minerals Separation processes." Is this expression confined to some particular process?

A. I may have used it in more than one sense in different answers, as at times I have had their various processes in mind, and at other times I have had the agitation froth process in mind.

40 X Q. Please describe the steps constituting this process which you term the "agitation froth process."

A. You mean the steps necessary in using this process, I assume.
The steps are not always the same nor always taken in the
51 same order on all ores. In the application of the agitation froth process to such an ore as that of the Butte & Superior Copper Company, the steps would consist of agitating an ore pulp consisting of finely ground or comminuted ore mixed with water, which had been acidulated with sulphuric acid and to which had been added a small quantity, less than one per cent., of what we usually term an oily re-agent, of which oleic acid is an example. This mixture is agitated with considerable vigor so that, when the agitated pulp is allowed to flow into a separating chamber or spitzkasten, the sulphide mineral contained in the ore rises to the surface of the water in the separating chamber as a froth, which is or can be flowed off and collected and which forms the valuable concentrate. These steps are repeated until the required extraction of the valuable ore constituents from the ore pulp has been obtained, when the tailings are allowed to go to waste or, if desired for reasons of economy, they are first dewatered. All of these steps form a continuous treatment of the ore pulp as it flows through the apparatus.

41 X Q. Please state a little more in detail how economy is effected by dewatering the tailings.

A. In some mining districts where fuel is a considerable item when used for heating the circuit liquor, as is usually necessary on an ore of the type described, the heated liquor can be recovered and returned to the system still warm enough to effect a saving in the fuel
requirement. Also, the preparation of this circuit liquor with
52 sulphuric acid and the frothing re-agent usually leaves the liquor that can be recovered from the tailings in such a con-

dition that less sulphuric acid and oily re-agent in required if the circuit liquor is used over again than if fresh water is used in mixing the ore pulp.

42 X Q. Do you mean that some of the oil or oleic acid does not attach itself to the concentrate but remains in the circuit water and goes to waste unless the circuit water is saved? Is that correct?

A. That is a theoretical explanation of what may take place, though as to whether or not it is the correct explanation, I am unable to say.

43 X Q. But the fact is, is it not, that some of the oil or oleic acid often remains in the waste water after the concentrate is separated?

A. I am hardly competent to answer that question, as I have never made any experiments to determine whether or not such is the case.

44 X Q. Unless some of the oily reagent you have referred to remains in the waste circuit liquor, how can it be, as stated, that less oily re-agent is required if the circuit liquor is used over again?

A. A reasonable explanation of such a condition would be that some of the oil may remain in the circuit liquor, but the phenomena on which flotation concentration depends are rather obscure and what seems to be a reasonable explanation may or may not be the true one.

53 45 X Q. When you first entered the employ of Minerals Separation, Limited, did you receive any instructions as to how to determine whether or not the flotation process which you have referred to as Minerals Separation process was applicable to any given ore?

A. Yes.

46 X Q. And what was the nature of these instructions?

A. To test the ore, and see how it worked by flotation.

47 X Q. Were there any instructions given you as to the mode of making such a test?

A. I think not at this time.

48 X Q. What was the nature of the first instructions that were given you regarding the method of testing ores to determine the applicability of this process to them?

A. The instructions given me were chiefly verbal instructions by Mr. Theodore J. Hoover, together with explanations of the workings of the testing plant in South Wales which were given to Mr. Hyde and myself by Mr. Hoover. Mr. Hoover also placed at my disposal a great deal of written and printed matter relating to the process of Minerals Separation, Limited, and other flotation processes, and relating to theoretical consideration of the phenomena on which these were based.

49 X Q. Were any instructions given you by Mr. Hoover or anyone else connected with Minerals Separation, Limited, as to
54 how to conduct a test of the applicability of this process to ores without the use of a testing plant such as the one you have referred to in South Wales?

A. My recollection is that, prior to the time that I went to Australia, this matter was discussed, but I think that I was not given any definite instructions myself on this exact point. Later, in Australia,

I witnessed a considerable number of tests in small machines which were designed for testing purposes and observed carefully how they were carried out. Still later, on my return to London, I witnessed a great many such tests in small testing machines.

50 X Q. How would you proceed to make a test in the field. That is a test for determining whether this process would be applicable to an ore which you might be called upon to test.

A. It would depend on the apparatus I had with me. If I did not have a small testing machine, I would take the finely ground ore, mix it with water and re-agents in a bottle, and shake the bottle vigorously. If the ore was easily amenable to flotation concentration, some indication of the formation of a froth would be made. If I had a testing machine, of which there are more than one type, I would put the ore, water and re-agents into the machine and agitate them together vigorously and note the result. If a mineral froth should be formed, I would skim it off in some way and again agitate the pulp, and see if an additional amount of froth could be formed, and so on until I become satisfied that further agitation would do no good. I would vary the conditions in different tests on any ore to see which set of conditions gave the best results. These variations would consist of agitation with or without sulphuric acid, with different oily re-agents, with agitating the pulp before acid should be added, with agitating the water, sulphuric acid, and oily re-agent before adding the ore, with agitating the pulp to some extent with the acidulated water before adding the oil, with using water of different temperatures, and, in fact, almost any combination or variation of these conditions that the indications given as I went along seemed to warrant.

51 X Q. Will you describe the general nature of the operations performed with the testing plant at London, England, which you have referred to?

A. The testing plant at London consisted of eight mixers, I think, in what we called the standard plant unit connected with five spitzkasten, I think the number is, entirely similar in appearance and apparent operation to the larger apparatus unit in the plant at Basin, Montana, together with means for feeding the pulverized ore, which at London was fed dry to the first or second mixer, and tanks for catching and collecting the products of any test. In these mixers were agitators and the ore, water, sulphuric acid, if used, and oily re-agent, were fed into the first or second mixer or perhaps later in some tests, and the ore pulp was vigorously agitated and then flowed into the initial spitzkasten, where a flotation froth was removed. From near the bottom of this spitzkasten a pipe led to the next mixer, where the ore pulp was again agitated and flowed into the second spitzkasten; and so on. If it was necessary to use heated solutions in testing any particular ore, the solutions were heated by adding steam to the pulp in one or more of the mixers.

52 X Q. When you were in Australia did you see what you have salled the Minerals Separation process in operation on a practical scale as distinguished from a mere test?

A. Yes.

53 X Q. Will you describe the manner in which this process was carried out in Australia?

A. It was carried out with two variations in two different plants. These plants were working on material, in one case coming directly from an ordinary wet concentration mill, and, in the other case, the material was zinc-bearing tailings which resulted from former operations of ordinary wet concentration mills. In the first one, the material coming from the wet concentration mill was dewatered and then fed to the flotation plant, where it was mixed with sulphuric acid and whatever frothing re-agent happened to be in use at the time. The ore pulp was heated by adding steam, agitated in mixers similar to the ones already described, only larger, flowed into spitzkasten where flotation froths were removed, and so on
57 until the operation was finished. The coarser material coming from the wet concentration mill was first reground to a finer condition before being fed to the flotation plant. The solution circuit was a closed one. That is to say, as much as possible of the water was recovered from the tailings and used over again. The operation in the other plant was similar as to the flotation part, except that dry material was fed in regrinding pans, where the coarser particles were reground to the requisite fineness and the whole pulp then passed through a classifier, which in part dewatered it, and the thickened pulp went to the flotation apparatus.

54 X Q. Where in Australia were these two plants you have referred to?

A. At Broken Hill, New South Wales.

55 X Q. Do you know of any other plants in Australia operating the flotation process? I mean the processes such as you have referred to as Minerals Separation processes.

A. There was a testing plant at the works of the Zinc Corporation, Limited. And I understood that there was a testing plant being used for experimental purposes at Bendigo by a Mr. Horwood.

56 X Q. At about what speed were the rotary agitators operated in the plants which you saw at Broken Hill?

A. At about 200 to 225 revolutions per minute.

57 X Q. What is the purpose of using these agitators?

58 A. To produce the froth.

58 X Q. How does the action of the agitators result in producing a froth?

A. The answer to that question would have to be a theoretical conclusion. It is believed by some of those who are familiar with these processes that it produces a froth by beating the ore pulp with sufficient violence to aerate the solution and that the resulting bubbles become attached to the mineral ore particles and when these have a chance to rise to a quiet surface, they do so, forming the concentrate froth.

59 X Q. Is the explanation which you have given your own belief as an expert in this art?

A. Substantially, yes.

60 X Q. Do you mean to imply by your answer that you personally would qualify this explanation in any way?

A. This explanation appeals to me as being a reasonable explanation—probably the most reasonable explanation—of what takes place, but as it is, from the nature of the phenomena, a theoretical explanation, it is open to the doubt which theoretical explanations usually are open to.

61 X Q. Is it your belief that agitation of a liquid with free access of air has the result of entraining air and aerating the liquid?

A. It depends on the head of the liquid above the agitator whether air in any quantity is entrained.

62 X Q. But if the liquid is of suitable depth so that the
59 agitator effectually agitates the liquid throughout and up to its surface, then would the liquid necessarily be aerated, that is, would air bubbles be introduced thereinto?

A. I think so, temporarily.

63 X Q. You have referred to a process which you have called the Everson process. Where did you gain your information regarding this Everson process?

A. I have read the patent granted to Carrie J. Everson.

64 X Q. Where did you secure your information regarding the process which you have called the Froment process?

A. I have heard Mr. Theodore J. Hoover talk about this process and I have read the Froment patent.

65 X Q. Do you mean the Froment English patent, No. 12,778 of 1902, of which I show you a copy (counsel shows copy to witness)?

Mr. Williams: Objection is here seasonably taken to cross questions 63-65, inclusive, as cross-examination not warranted by the direct examination and by way of anticipation of defendant's case. The reference in the direct examination to Everson and Froment was merely a narration repeating a statement of the defendant.

A. My recollection is that I have read this patent but I cannot say that I have studied it carefully.

60 66 X Q. Did the operation of the plant in South Wales, to which you have referred, prove successful at the time you witnessed its operation?

A. It was a testing plant making tests on an ore which had been shipped there, I was told, for the purpose of finding out whether such ore was or was not amenable commercially to the process of Minerals Separation, Limited. At the time of my visit there, the ore was being tested under one set of conditions, but I understood that it had been tested under other sets of conditions previously. In such ore tests, it is rather difficult to say whether a test is or is not successful, as all of the results obtained are indicative and important.

67 X Q. Was the process which was tried on this ore in South Wales introduced into actual practice as a result of the tests?

A. My information is that a plant has recently been erected at the mine where this ore originated and that very satisfactory results have been obtained.

Mr. Kremer: Defendant moves to strike out all of the answer to X Q. 67 on the ground that the same is based upon hearsay and it is apparent from the answer that the witness has no personal knowledge of the matters stated therein.

68 X Q. Did you keep or make observations as to the efficiency of the process which you witnessed in South Wales, and were those observations of the results secured such as are demanded in practice?

61 A. I do not recollect making any notes relating to the operation of that plant at the time I visited it, though I observed as much as I could and remember as much of my observations as possible.

69 X Q. About what quantity of oily matter or oleic acid relative to the weight of the ore have you seen used in the application of the process which you have called the Minerals Separation process?

A. The quantity used varies with different ores, and with different oily re-agents. Usually a few pounds of oily re-agent at the outside, per ton of ore, is sufficient to give the desired results.

70 X Q. What are the maximum and minimum limits which you intend to indicate by the expression "a few pounds of oily re-agent" per ton of ore?

A. Good results on an ore are usually obtainable with less than ten pounds of oily re-agent, per ton of ore.

71 X Q. Is it your opinion that agitation has any effect in the practice of the flotation process other than its effect in introducing air?

A. Yes.

72 X Q. What other effect does agitation have?

A. My opinion is that it has the effect of thoroughly mixing together the different ingredients in the ore pulp.

73 X Q. And what is the object of thoroughly mixing together the different ingredients in the pulp, and what ingredients do you refer to?

62 A. The object is to produce a flotation froth and the ingredients I refer to are the finely ground ore, the water, and such re-agents as are found to be necessary.

74 X Q. These re-agents which you have last mentioned are the oily matter or oleic acid, are they not?

A. Yes, and sulphuric acid, if that is used.

75 X Q. Is it your belief that the agitation assists in bringing the oily matter or oleic acid into contact with the valuable constituents of the ore which subsequently float?

A. Yes.

76 X Q. Is a considerable degree of agitation necessary to bring the oily matter or oleic acid into intimate contact with the valuable constituents of the ore?

A. Usually, yes.

77 X Q. Are there any conditions under which in this process agitation would not be necessary to bring the *only* matter or oleic acid into contact with the valuable constituents of the ore?

A. A certain amount of stirring might suffice in the treatment of some ores.

78 X Q. What distinction do you make between stirring and agitation?

A. By stirring, I mean a more gentle agitation than I have referred to previously as being necessary in the treatment of an ore by the agitation froth process.

79 X Q. Have you ever seen any ore treated by this gentle stirring process? I refer to processes in which flotation of the valu-
63 able constituents of an ore is produced by treating the ore with oil and subsequently floating the ore by the conjoint action of the oil and air or other gas.

A. Yes.

80 X Q. How much oil was used in this operation; that is, how much per ton of ore?

A. I do not know of my own knowledge.

81 X Q. What was the nature of the ore used in this operation which you have just referred to?

A. It was zinc-bearing tailings, resulting from the previous operation of wet concentration mills.

82 X Q. Where was this process carried out, and when?

A. At Broken Hill, New South Wales; at the time of my visit there in 1910.

83 X Q. By whom was it practised?

A. By the Zinc Corporation, Limited.

84 X Q. Will you describe all of this process so far as you are able to from your personal observations of it?

A. The ore which was operated on by the process used was prepared for flotation by having its coarser particles ground to the requisite fineness, and the resulting ore pulp flowed to hydraulic classifiers or spitzkasten. These classifiers delivered to the subsequent apparatus two products, an underflow and an overflow. The overflow product was delivered to a mixing vessel, where sulphuric acid and oil were added and the pulp was thoroughly mixed
64 in this mixing vessel by a relatively slow moving mixer. The mixed ore, water, sulphuric acid and oil flowed from this mixing vessel into the open end of a U-shaped tube. Powdered limestone was also added into the open end of this tube and the sptizkasten overflow was also added in whole or in part. At the upper end of this U-shaped tube, of which the limbs were of unequal length, there was an enclosed chamber, within which a vacuum was maintained. From the bottom of this vacuum chamber, a pipe led to a tailings belt and the bottom end of this pipe was kept immersed beneath the surface of water maintained by troughing this tailings belt. The bottom end of this tailings pipe also had an automatic valve, which could be adjusted to meet the rather delicate necessities of the operation of the machine. The vacuum chamber also had in the bottom of it some arms, which rotated slowly and kept the material that settles to the bottom of the vacuum chamber gently stirred. The water surface in the vacuum chamber could be observed through glass windows provided for the purpose and was con-

fined to an annular ring surface slightly below a lip, over which the concentrates bubbled and flowed. The concentrate was led away to another belt and delivered to that belt in a way similar to the tailings, except there was not the automatic valve at the end of the delivery pipe. The concentrates were drained of water and otherwise dried out and then delivered to what were called deoiling
65 furnaces, where the oil was burned off. After the oil was burned off, the de-oiled concentrates were delivered to an ordinary wet concentration mill, where the grade of the zinc concentrate was raised and a lead concentrate was made. In general, the apparatus was wholly different from the Minerals Separation apparatus and the apparatus installed at Basin, Montana.

85 X Q. Will you describe more in detail the mixing vessel referred to in your last answer and the means used for thoroughly mixing the sulphuric acid, oil and pulp?

A. This mixing vessel consisted of a horizontal trough, into one end of which the ore pulp was fed and which delivered the mixture at the other end. In this trough there was a horizonal shaft, to which were attached a considerable number of blades so shaped as to direct the pulp from one end to the other. This shaft was rotating at the time of my inspection between 60 and 70 revolutions per minute.

86 X Q. How did the surface of the pulp in the mixing vessels appear when the agitators were operating?

A. I did not see the surface when these mixers or agitator blades were operating, as the mixing trough was kept covered, while the mixer was running.

87 X Q. Do you know what the purpose was in keeping the mixing trough covered when the agitators were operating?

66 A. I do not recollect seeking information on this point, though I presume the purpose was to confine the splash that may have been formed.

88 X Q. About what was the diameter of these mixing vessels?

A. I do not recollect having measured the diameter, though I think at the widest part they were about 12 to 14 inches outside measurement.

89 X Q. Do you know the form and size of the agitators used?

A. I saw one of these mixing vessels opened which was out of use, and looked at the interior and saw the mixing blades. As I said before, these blades were arranged on a horizontal shaft and so shaped as to direct the ore pulp from one end to the other end of the mixing trough. I used the term "mixing trough" and "mixer" advisedly, as that is what the workmen and others connected with the operation of the plant called them.

90 X Q. About what, to your best recollection, was the size of the agitators or mixing blades, as you term them?

A. My recollection is that these blades were a few inches long and two or three inches wide, and they were set similar to the blades of a propeller with reference to the longitudinal axis of the shaft.

91 X Q. What was the structure of the cover which was placed over the mixing trough while the mixture was being rotated?

67 A. I do not recollect exactly.

92 X Q. This process which you have just been describing in your last previous answer is known as the Elmore vacuum process, is it not?

A. I believe so; yes.

93 X Q. According to your recollection, about how many blades were there upon the horizontal shaft of the agitator or mixer in the apparatus of the Elmore vacuum process?

A. I do not remember exactly except as to general appearance. The trough of the mixer was about six or eight feet long and my recollection is that the blades were arranged on this spirally so as to rotate through practically the whole of the interior space.

94 X Q. That is, axially of the shaft the blades were practically continuous, although spirally arranged as you say?

A. Yes.

95 X Q. Were all of the blades inclined in the same direction, if inclined at all, as I understand they were?

A. My recollection is that they were, though I do not remember the arrangement with sufficient exactness to state so positively. My recollection is that it was of the ordinary trough type of mixer, similar to what is used in mixing lime with ores for some of the briquetting machines such as I have seen.

96 X Q. How far were the upper part of the uppermost
68 blades in the mixer of the Elmore vacuum apparatus submerged beneath the surface of the pulp?

A. As I have stated before, I did not see the machine open while it was operated, but it was my understanding of the arrangement that only the lower part of the mixer blades were submerged in the pulp.

97 X Q. Did you have any opportunity to form an approximate idea as to the proportion of oil or oleic acid to ore that was used in the Elmore vacuum process as you witnessed it?

A. My only information on that point is information which was furnished to me by the Assistant Superintendent of the plant and is therefore hearsay knowledge.

98 X Q. What is your idea, as an expert in this art, as to the amount of oil in proportion to ore necessary in the practice of the Elmore vacuum process in the way you saw it practised?

A. My idea of the amount and kind of oil to ore used in the practice of the Elmore vacuum process as I saw it exemplified at Broken Hill is that about ten or twelve pounds of petroleum residuum was being used per ton of ore.

99 X Q. In froth flotation processes of the general type referred to by you as the Minerals Separation process, does any unfavorable result occur if a comparatively large amount of oil is used, say a hundred pounds to the ton of ore?

A. My observations have been that when such a quantity of oil as this is used, that the resultant effect ceases to be ac-
69 curately described as a froth flotation process, as a different set of phenomena are apt to come into play.

100 X Q. Will you describe these other phenomena which you

refer to, which are incident, as you say, to the use of a large amount of oil?

A. I have not seen, except with small scale experiments, any such amount of oil as you describe used. In some small scale tests I have seen, where a quantity considerably in excess of the amount used to produce frothing was tried, though I am not sure nor do I recollect whether the quantity was such as you indicate, the effect was to gather the valuable mineral of the ore into granules, which remained at the bottom of the vessel in which the experiment was tried.

101 X Q. Was more or less concentrate floated at the same time that some of the concentrate was formed into granules and precipitated?

A. Not in the tests which I saw.

102 X Q. In this test which you refer to, then, as I understand you, no mineral whatever floated?

A. I could not say that.

103 X Q. Wasn't it the case that in this particular test you have referred to or some others that you have seen or made, that part of the mineral was precipitated and part floated?

A. As a matter of fact, I have witnessed very few tests made for the purpose of obtaining this granulation of the mineral,
70 which is commonly called the Cattermole effect, and in the tests which I did witness the bulk of the mineral was precipitated, though there may have been a small portion floating as a sort of skin on the surface of the water after agitation had ceased, but such a skin was not a part of the effect aimed for and could not be referred to as a concentrate.

104 X Q. Were these tests or experiments with the Cattermole process carried out in apparatus similar to that used in experimenting with the flotation process which you have referred to as Minerals Separation flotation process?

A. The only tests giving the Cattermole effect which I saw and which were aimed to give the Cattermole effect were carried out in bottles.

105 X Q. Just what was the procedure in making these bottle tests of the Cattermole process?

A. I witnessed these experiments merely as a spectator and my observation of the procedure was not particularly careful, but as I recollect it, the ore bearing mineral, together with water, oil and, I think, acid, was put into a bottle and the bottle was shaken. After the bottle had been shaken some little time, considerably longer, in fact, than is necessary to obtain indications of a froth when making a bottle test by the frothing process, small granules of mineral could be observed in the bottom of the bottle. Additional shaking appeared to result in larger granules being formed. There was an oily appearing scum on the surface of the water in the
71 bottle when it stood quietly, which oily appearing scum or film may have had a little mineral in it. As I understand the Cattermole process, it is usual to provide an up-cast of water which washes the gangue mineral of the ore up and away from the granules which have been formed, these granules being heavy enough

to sink through the up-cast current of water and are collected and form a concentrate. In a bottle, of course, such a procedure was not possible, the granules merely being heavy enough to sink to the bottom and not float.

106 X Q. What difference in mode of procedure cause the Cattermole effect of precipitation to be obtained under some circumstances and flotation of the larger part of the concentrate under other circumstances?

A. I really am not qualified to testify on this point, as I have seen so little of the Cattermole process. It is my understanding, however, that the chief difference in the results is brought about by the difference in the quantity of oil used.

107 X Q. Is it your opinion, then, that in those cases where the larger part of the valuable mineral is floated as a froth or scum, oil has been used in quantities insufficient to bring about the precipitation which is characteristic of the Cattermole process?

A. Not necessarily.

108 X Q. Is it a correct inference from your answer, then, that flotation of the metalliferous mineral as a concentrate is in a measure independent of the quantity of oil or oleic acid used?

72 A. No.

109 X Q. What other elements enter into the distinction between producing the Cattermole effect and producing flotation besides the proportion of oil or oleic acid to ore?

A. Flotation can be produced by the action of a rather strongly acidulated, hot sulphuric acid solution directly on some ores when oil is not being used at all.

110 X Q. In those processes in which oil is used are there any other elements besides the quantity of oil that bring about the two effects, namely, the Cattermole effect and the flotation effect?

A. I really am not qualified to testify as an expert on the Cattermole effect, as I have observed it so little, and, consequently, am unable to answer your question intelligently.

111 X Q. Did you never notice this Cattermole effect in tests or actual operation in which that effect was not sought for?

A. I have observed effects in tests where the mineral did not float that may or may not have been the Cattermole effect. There was a sort of a loose agglomeration of mineral particles in the bottom of the vessel used after agitation had ceased, but these mineral particles did not resemble in all particulars the Cattermole granules which I have observed.

112 X Q. In those cases where you noticed such a loose agglomeration of mineral particles in the bottom of the vessel after agitation, there was a certain loss of concentrate in the floating matter, was there not?

73 A. Not always.

113 X Q. Of what did this agglomerated matter at the bottom which you have referred to consist?

A. Of mineral particles, apparently.

114 X Q. Of what kind of mineral particles?

A. In the tests I have seen, of sulphide mineral particles.

115 X Q. Was this a desirable condition of affairs to have these sulphide particles settle to the bottom, in the course of a flotation process?

A. In the course of a test this condition did not usually make much difference, as further agitation was usually adequate to convert these agglomerated masses into a froth. I have not observed this effect in commercial plants especially, as the conditions are usually adjusted so as to avoid any of these agglomerations being discharged with the tailings.

116 X Q. What kind of adjustment is made to prevent the discharge of these agglomerations with the tailings?

A. As I said, I did not notice them being formed especially in any commercial plant which I have observed, and did not study especially what the adjustment would be to avoid this particular effect.

117 X Q. Do you mean that if you found these agglomerates of sulphide settling to the bottom and being discharged with the tailings, you would not know what to do to prevent such a loss?

A. No.

118 X Q. Do you mean that you would not know what to
74 do? Or do you mean that you did not intend to convey the idea that you would not know?

A. I meant that I did not intend to convey the idea that I would not know what to do.

119 X Q. Then what would you do?

A. I would alter the adjustment of operations step by step until I found a condition wherein these granules were not discharged with the tailings.

120 X Q. What particular adjustment would you think of altering first?

A. There are several adjustments which might occur to anyone skilled in the art and which would, I think, occur to me. One of them would be to alter the rate of flow of pulp through the plant. Another would be to alter the speed of agitation. Another would be to alter the quantity or kind of oil used on the particular ore being treated. Another might be to alter the dilution of the solution circuit with reference to dissolved salts therein. Another might be to alter the temperature of the solution circuit. Another might be to vary the internal arrangement of baffles or other diverting devices so as to affect the direction of flow of the ore pulp. All of these adjustments might have some effect or considerable effect or any of them might have effect upon the formation of the agglomerations which I have described.

121 X Q. Have you any information which would enable you to ascertain in advance which of these elements needed readjustment, or would you simply proceed haphazard until you struck the right combination?

75 A. I think it is likely that an inspection of a plant by one skilled in the art, which was operating in the way described, would indicate to him the probable adjustment called for in the particular case he was studying.

122 X Q. You are one of those skilled in the art to whom you refer, are you not?

A. Yes.

123 X Q. If the oil supply needed readjustment, according to your diagnosis of the trouble, what would you do to remedy this agglomeration and settling of sulphides? Would you increase the oil supply or diminish it?

A. I would readjust it, but I could hardly say whether I would increase or diminish the supply from the data you have given.

124 X Q. You think then, do you, that it might be necessary sometimes, in order to prevent agglomeration and settling of the sulphides, to increase the oil supply?

A. That might depend on the particular kind of oil being used. The effects are so various with the different oils under different conditions that it is hard to say in advance what I would do without studying a particular case of ore treatment where this effect was occurring.

125 X Q. Can you, from your information as an expert in this art, lay down any definite rule as to the course to be pursued to produce the flotation effect without that effect being accompanied by the settling of the agglomerated masses of sulphide?

76 A. In particular cases, yes.

126 X Q. State some particular case and give us the rule for the correction of the agglomeration and settling effect.

A. In an ore containing zinc sulphide and gangue mineral, in which it was found to be necessary to use for the treatment by flotation thereof to give the best commercial results, a mixture of finely ground ore, water heated above the atmospheric temperature, sulphuric acid and oleic acid, if it should be found that adjustment of the other elements which I have previously described did not produce sufficient diminution of this agglomerating effect, and if it had been found that all or most of the mineral occurring in the ore could be floated as a concentrate froth and was not doing so, I would expect, if the quantity of oleic acid used was in excess of the usual amount found necessary in the treatment of such ores, that a diminution of the quantity of oleic acid would reduce this agglomerating effect, and I would lay down a rule, then, that such quantity be reduced under these conditions.

127 X Q. As I understand this rule of procedure, it consists in readjusting all but one of the possible elements of the process and, in the event that the defect was not thereby removed, you are led to the conclusion that something must be done with the only remaining element. Is that the best rule that can be laid down?

A. Not necessarily, no.

77 128 X Q. If you know of any better rule, I would like to have you state it while we are upon this subject.

A. The case might be that this effect had become evident when there had been no apparent or great variation in the other elements and the first inference would be, and a rule would be, to vary the oil adjustment the first thing.

129 X Q. What effect has heat upon the operation of the so-called Minerals Separation flotation process?

A. It has the effect of assisting the flotation, of giving usually a cleaner concentrate, and some ores will not give a flotation concentrate without heat; that is, commercial concentrate.

130 X Q. Does the use of heat have any relation to the oil or oleic acid which is used?

A. When oleic acid is being used as the floating agent, we usually find that the results are better in a heated circuit than in a cold circuit.

131 X Q. At what temperature does oleic acid solidify?

A. I do not know.

132 X Q. At any ordinary climatic temperature, do you know?

A. Commercial oleic acid is usually impure and will solidify during cold weather if not warmed artificially.

133 X Q. It would obviously be impossible to carry out this flotation process with solid oleic acid, or any other process dependent upon the distribution of the oleic acid among the ore particles, would it not?

78 A. I have never experimented with an ore using solid oleic acid and I do not know whether it would be obviously impossible or not.

134 X Q. As an expert in this art, then, you think it might be possible to carry out the process which you have called the Minerals Separation flotation process with oleic acid in the form of a solid. Is that correct?

A. No, that is hardly correct. I am in the position of saying that I have not experimented along this line and I do not know what the effect would be on any particular ore, if solid oleic acid was being used.

135 X Q. You are unable to state, are you, whether or not it would be likely to prove of advantage to liquefy the oleic acid by heat prior to attempting to carry out the so-called Minerals Separation flotation process?

A. It would be of advantage to liquefy the oleic acid by heat up to the point of introducing it to the pulp in order to get an easily controlled regulation of the amount of oleic acid being added to the ore. Whether or not a solidified oleic acid in the ore pulp itself would be an advantage or a disadvantage, I do not know, as I have not experimented along that line.

136 X Q. Do you think that in the practice of the so-called Minerals Separation flotation process there would be any advantage in varying the temperature of the mass of the pulp to adapt the temperature to oils of different degrees of viscosity?

79 A. That question has not come, to my recollection, in my experience, and I could hardly give an authoritative opinion upon it without experiment.

137 X Q. Your experience as an expert in this art does not enable you to throw any light on this question of adapting the temperature to the viscosity of the oil?

A. In general, I would expect that, when an oil was being used

that was viscid at the temperature of the ore pulp at any given instant and good results were not being obtained, better results would be obtained if the temperature of the ore pulp should be raised.

138 X Q. In case you were subjecting the ore of the Butte & Superior Copper Company to the so-called Minerals Separation flotation process, adjusting the conditions according to the proper practice as you understand it, with the exception of using an amount of oleic acid equal to four per cent. by weight of the ore, what result would you expect to follow?

A. As I have before stated, I cannot qualify as an expert on the Cattermole process, but, from what I do know of it, I would expect with this quantity of oil to find that the so-called Cattermole granules were formed to some extent and that perhaps some oil would be floating on the surface of the liquid in which some mineral might be entangled. In other words, the so-called Minerals Separation flotation process, as you term it, would not be in evidence.

139 X Q. Where is the exact line where you would distin-
80 guish between the Cattermole process and the process which you have termed the Minerals Separation flotation process?

A. My experimental work on different ores and on the ore of the Butte & Superior Copper Company has been directed to the end in part of getting the flotation concentrate with a minimum amount of oil on account of commercial considerations, and I have not done any work along the line of attempting to find out how much oil can be used and still obtain the frothing effect, and I am unable to say just where this line would be.

140 X Q. The use of the minimum quantity of oil is important in the resulting economy, is it not?

A. The minimum amount which can be used without affecting unfavorably the recovery or the grade of concentrate is important from the standpoint of economy.

141 X Q. As I understand you, you have not sufficient information about the Cattermole process to enable you to state in figures the exact point where the Cattermole precipitation results in contradistinction to the frothing of the so-called Minerals Separation frothing process?

A. That is correct.

142 X Q. I presume the determination of the line of separation between these two effects would, with different ores, necessitate some experimentation; is that correct?

81 A. I would presume so.

143 X Q. Is the quantity of oil relative to ore used in the so-called Minerals Separation flotation process in any way related to the richness of the ore, that is, to the percentage of valuable sulphides which it contains?

A. I could not say definitely.

144 X Q. Is it your understanding that the oil coats the sulphide particles of the ore in preference to the rocky gangue particles?

A. It is my understanding that the oil attaches itself under proper conditions to the sulphide particles of the ore rather than to the rocky gangue particles.

145 X Q. But you are unable to state whether the quantity of oil necessary has any relation to the percentage of sulphides in the ore?

A. It is reasonable to believe that there would be some such relationship, but I have no definite information on this point.

146 X Q. What would your judgment be, as an expert in this art, as to the necessary relation between the quantity of oil or oleic acid relative to the richness of the ore in sulphides?

A. My judgment would be that for a heavily mineralized sulphide ore as compared with a lean sulphide ore that the heavily mineralized ore might take a little more oil to give the same degree of flotation, but my experience has been that a solid sulphide ore can be floated almost completely with a small amount of oil, not much
82 greater, in fact, than is necessary in the ordinary treatment of a much leaner ore.

147 X Q. Is there any necessary relation between the amount of oil used and the fineness to which the ore is crushed?

A. I could not say definitely on that point, as the quantities of oil used are all very small in the Minerals Separation practice.

148 X Q. Is there any necessary relation or any relation which it is of advantage to observe between the amount of oil used and the state of dilution of the pulp being treated?

A. I could not say definitely.

149 X Q. Referring to the operations which you saw at Basin, Montana, you stated that the froth flowing into the launders was the typical appearing agitation froth as made in plants using the Minerals Separation flotation froth process. What are the characteristics of this typical froth?

A. It would be a bit hard to describe these characteristics in such a way that another could recognize the froth as being typical, but I have come to know this froth when I see it as I know my wife when I see her, though I doubt if I could describe her with sufficient accuracy so that she would be recognized if seen on the street by the person to whom I described her.

150 X Q. Perhaps you can describe some of the characteristic features of this froth, even if you cannot enable the Court to
83 recognize it when it sees it. Will you attempt to do so?

A. It is usually a froth similar in some ways to a sudsy froth and would be not unlike, I think, such a sandy froth if it were imagined full of finely divided mineral matter. It floats on the surface of water, its color depends on the color of the mineral contained it in and forming a part of it, the bubbles are of various sizes and there is frequently what might be called a pitted condition to the upper or air surface of the froth due to the breaking of some of the bubbles. When oleic acid is being used as the frothing agent, there is what might be called a toughness or persistency to the froth that can usually be noticed.

151 X Q. Is a froth of the character you have described formed when you mix finely ground ore with water and oily matter or oleic acid and sulphuric acid in a bottle and shake the bottle as you have described in connection with the testing of ores?

A. I assume in my reply that the ore is of such a nature as to yield a froth under these conditions and in general the froth would have the appearance described except that the quality which I have referred to as the "toughness or persistency" of the oleic acid froth is not so evident in small scale tests as it is in larger scale work where the froth is being formed in quantity.

Adjourned to Saturday, February 17, 1912, at 10:30 A. M.; at the same place.

84 New York, February 17 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Mr. Nutter continued:

152 X Q. Mr. Nutter, will you state what the designation is of the position which you hold with the Minerals Separation American Syndicate, Limited?

A. I hold the position of Chief Engineer.

153 X Q. What is the nature of your duties in that position?

A. My duties as outlined to me by the Board of Directors of this Company were rather of a general nature, that is to say, I did not have any restrictive instructions as to what I should do, but I was in general to search for flotation business in North America, to examine mines or ore bodies or ore dumps, as occasion might arise, and advise the Board and the agents of the Company on engineering matters connected with such examinations, to test ores, to negotiate business, and, in general, to promote the Company's interests in North America.

154 X Q. In the discharge of your duties, does it devolve upon you to determine whether or not certain ores or tailings, as the case may be, are amenable to the flotation treatment and, if so amenable, to determine the detailed mode of treatment?

A. Yes.

155 X Q. Do you know what the purpose was in only
85 partially submerging the mixing blades of the agitator in the apparatus which you saw used for the practice of the Elmore vacuum process?

A. As I have already stated, I did not see these mixing vessels operating uncovered and based my statement that the blades were partially submerged on hearsay information. I was not informed, to my recollection, as to any particular reason for doing this, though from the construction of the mixing vessel it would seem to me to be a reasonable thing to do from mechanical considerations.

156 X Q. Do you understand the theories underlying the practice of the Elmore vacuum process?

A. In a general way, yes.

157 X Q. Will you state the theory of operation of the Elmore vacuum process so far as you understood it?

A. As I have previously stated, the vacuum chamber of the Elmore machine is connected at the bottom with one limb of the U tube,

which I have in part described. This U tube is a long pipe, as I recollect it approximately of barometric height, and when the mixture of ore pulp is fed into the shorter end of it, it, of course, flows downward through the bottom of the U and up into the vacuum chamber. In this mixture, as I have stated, are powdered limestone and free sulphuric acid. It is a well known fact that under atmospheric conditions water usually has a certain amount of air dissolved in it. Now, as I understand it, the theory of the operation of
86 the Elmore vacuum machine is, that, as the mixed ore pulp rises in the longer limb of the U tube, there is a decreasing pressure therein as compared with atmospheric pressure on account of the vacuum maintained at the top of the vacuum chamber. It is believed, I understand, that the reduction in pressure as the mixture rises results in bubbles of air being formed; that is, the air which was previously in solution is changd to bubbles of free air and becomes attached to the oiled mineral particles. Also, it is believed that if all of the air normally in solution were drawn out of the solution, as it were, there would still be an insufficient quantity of air to float the mineral in such an ore as the Broken Hill zinc tailings, for instance. Consequently, it is the theory, I believe, that additional gas has to be formed or introduced into the ore pulp mixture and I was told it was for that reason that limestone, powdered, and free sulphuric acid were added in the U tube, the reaction between these substances producing carbonic acid gas, which also becomes attached to the mineral particles and floats them to the surface of the liquid in the vacuum chamber. This liquid surface, as I have previously stated, is maintained at a level just below that of a lip which confines the liquid. As the bubbles of ore-bearing froth reach this surface, they collect to some extent and flow over this lip and are then led away and form the concentrate.

158 X Q. Is it your belief, as an expert in the art, that the explanation which you have just given is the correct explanation?

87 A. It seems to me to be a reasonable explanation and I know of no better explanation, though, of course, it is a theoretical explanation and open to such objection.

159 X Q. As I understand you, in the practice of the Elmore vacuum process, as you witnessed it, the carbonic acid gas formed by the reaction of sulphuric acid on limestone supplements the action of the air which is caused by the vacuum or partial vacuum to leave its state of solution and to form bubbles. Is this correct?

A. Either effect, I think, could be held to supplement the other, depending on the point of view of the person who was theorizing.

160 X Q. That is, the carbonic acid gas and the air both perform the same function, one supplementing the other and each contributing to the same results. Is that correct?

A. That is the explanation I have heard and that is my understanding of the matter.

161 X Q. Suppose the gas were introduced into the pulp in the practice of the Elmore vacuum process by some other means, such, for instance, as electrolysis, would the gas so released contribute to

the flotative effect in the way that you have stated that air and carbonic acid gas do?

A. I could not say, as I have never seen such an experiment tried.

162 X Q. What is your judgment from your wide experience in this art, as to whether gases released electrolytically would
88 act in the same way as you have described in connection with carbonic acid gas and air as utilized in the Elmore vacuum process?

A. I really could not say or give an intelligent judgment on this point, as there might easily be other conditions introduced by electrolytic treatment which would have unforeseen consequences.

163 X Q. Other things being equal, I presume that the action of a gas in the pulp being subjected to a flotation treatment is independent of the origin of the gas, the question assuming that all other conditions remain the same except the method of generating or forming the gas itself?

A. Not necessarily.

164 X Q. Is it your judgment as an expert that, in the practice of a flotation process using oily matter or oleic acid in quantity insufficient to raise the mineral by virtue of the flotation powers of the oil alone, such flotation could be secured, if desirable, by gaseous bubbles produced by electrolytic method or by means of various other known reactions?

A. I assume in my answer an ore which is amenable to the agitation froth process, and I think it would be reasonable to expect some flotation of the mineral, but my judgment would be that a person could not answer this authoritatively without experimenting under the given conditions, as we find in such experimental work that some modifications and variations of the conditions have at times unexpected results.

89 165 X Q. Assuming that such experimentation as you have referred to with gaseous bubbles produced by electrolytic methods and by means of various other known reactions did result in causing flotation, the amount of oil used being in itself insufficient to produce that effect, would it be your judgment that each of the gases produced by these various methods had performed the same function in bringing about the flotation?

Mr. Williams: Objected to as an effort to obtain from the present witness in complainants' prima facie testimony evidence anticipatory of the defense and as not warranted by the direct examination.

A. I assume in my answer that you mean the amount of oil used being in itself insufficient to produce that effect by its own buoyancy as compared with water. It would depend on the appearance of the floating mineral as to what my judgment of the experiment would be.

166 X Q. Assuming the existence of the conditions set forth in X Q. 165, would it be your judgment as an expert in the art that the flotation of the froth or scum was a result caused wholly or in part by the action of the different gases produced by the various methods referred to in that question?

Mr. Williams: Same objection.

A. In your question you assume that a froth or scum would be formed. I can conceive it as being possible that under the
90 conditions described a film of mineral only might be formed. If I had observed, however, that the mineral was being raised to the surface by the gases produced and remained there attached to bubbles of gas, or remained there as such a film as I have described, my judgment would be that the flotation was a result caused wholly or in part by the action of the different gases produced.

167 X Q. It is a fact, is it not, that gases can be produced or generated in various ways?

A. That is a matter of common knowledge, I believe.

168 X Q. Assuming that in a serious of operations gases produced in different ways are introduced under precisely similar conditions into a pulp containing ore to which insufficient oil has been added to produce flotation by the effect of the oil itself, is it your judgment as an expert in this art that these gases introduced into the pulp under similar conditions would have any different effect or function growing out of the fact that they had been produced or generated in different ways?

Mr. Williams: Objection to 165 X Q. repeated.

A. As flotation concentration is an experimental art I am unable to give an intelligent judgment on this point, as I have not witnessed any experiments which would enlighten me in the matter.

169 X Q. Does your expert knowledge in this art enable you to state any reason why the action of gases introduced into a
91 pulp containing oil insufficient in itself to produce flotation would in any way be dependent upon the method of generating or producing said gases, it being assumed that the gases are introduced into the pulp under the same conditions however generated or produced?

Mr. Williams: Same objection.

A. I am unable to state any reason why the action of gases so introduced would in any way be dependent upon the method of generating or producing said gases, but it is my belief that a variation in the method of introduction of these gases may give variant results.

170 X Q. Do you base your belief that a variation in the method of introducing the gases may give variant results upon any actual experience which you have had in the practice of the flotation process?

Mr. Williams: Same objection.

A. No.

171 X Q. In the case of zinc ores, how low grade an ore can be successfully treated by what you have called the Minerals Separation frothing process?

A. The answer to this question would depend very largely upon the local economic conditions at the point where the zinc ores were

produced and upon the terms of sale of the resulting zinc concentrate, and upon the actual treatment requirements of the ore.

172 X Q. Putting aside for the time being the question of
92 the degree of profit of the operation, how low a grade of zinc ore could be subjected to what you have called the Minerals Separation flotation process with the result of separating by flotation the zinc sulphide, assuming that the zinc existed in that form?

A. In the case of a zinc ore containing zinc as zinc sulphide such as is produced in some of the mines at Butte, Montana, it is my belief that a salable zinc concentrate could be produced from ores of very low grade. By low grade I mean carrying zinc to the extent of only a few per cent. There would be, of course, a lower limit of grade where profits would cease.

173 X Q. Will you state numerically what you mean by a few per cent.?

A. I believe, from the tests which I have made or have had made on the Butte, Montana, ores described, that a salable concentrate could be produced from an ore carrying as little as one per cent. of zinc in the form of zinc sulphide.

174 X Q. Does the one per cent. refer to metallic zinc or to the compound zinc sulphide?

A. It refers to metallic zinc.

175 X Q. Is the process which you have called Minerals Separation flotation process applicable to ores of any degree of richness in zinc sulphides, that is, to ores running very high in zinc sulphides?

A. Yes.

176 X Q. How high, to your knowledge, do any known ores run in zinc sulphide or in metallic zinc, however you prefer to state it?

93 A. Selected samples of zinc ore, of course, may consist of practically pure zinc sulphide, and have the corresponding percentage of metal present therein as is found in practically pure zinc sulphide. Usually, however, a zinc ore is considered of good grade under the normal working conditions in established mining camps when it carries, say, twenty per cent. of metallic zinc on average. It is considered of high grade when it carries upwards of this, and I have known of ores running in some quantity as high as thirty-five or forty per cent. of zinc or more.

177 X Q. Is oleic acid known under any other name?

A. Yes, it — sometimes known as red tallow oil.

178 X Q. Is it ever known as candle makers' red oil?

A. It may be, though I do not recollect having heard that designation, but such a designation would be a good description of it.

179 X Q. Do most organic oils and do most fats contain oleic acid?

A. I do not know this definitely, but I understand that many of the animal fats contain oleic acid.

180 X Q. Will you state what the written and printed matter relating to the processes of Minerals Separation, Limited, which was placed at your disposal by Mr. Hoover, consisted of?

A. There was a book on a study of splashes, there was the record of the testimony in the patent suit between Minerals Separation, Lim-

ited, and the Elmore Company or whatever its corporate name
94 was, there was a large mass of experimental data on studies of the phenomena called surface tension, there was a resume of patents relating to flotation, and a file of flotation patents. My recollection is that there were other papers, though I do not remember what at this time.

181 X Q. Did you study the various patents, data and other literature referred to in the last question and answer?

A. Yes, I read them all over, so far as I recollect, and studied more carefully the parts that interested me and seemed to me to be important.

182 X Q. Then I take it that, to some extent, your expert knowledge of flotation processes is derived from the patents contained in the resume of patents and in the file of flotation patents referred to by you?

A. Yes, to some extent.

183 X Q. In the Elmore vacuum process, is it your judgment, based upon your knowledge of the flotation art, that the pulp in the vacuum chamber of the apparatus used contains more air in solution than it would if it had not been subject to the action of the agitator or mixing blades which you have described?

A. It is my understanding of the theory of the Elmore vacuum process that, by the time the pulp reaches the vacuum chamber, the most of the air has been drawn out of solution and that there is not as much air left in solution as there is ordinarily in water at the same temperature under atmospheric pressure.

95 184 X Q. Is it your opinion, as an expert in this art, that the water forming the ascending column of liquid in the long arm of the U-shaped tube which leads to the vacuum chamber contains more air in solution than it would contain if the pulp had not been agitated by the agitator or mixing blades, the question referring especially to the part of the pulp in the lower end of the long arm of the U-shaped tube where it is not under appreciably diminished pressure?

A. I see no reason for believing that it would contain more air in solution than it would have contained had it not been passed through the mixing vessel, as the mixing blades rotate at a much less speed than we have found necessary in operating the agitation froth process in order to affect the quantity of air in solution. That is to say, the speed of the mixing blades in the mixing vessel in the Elmore vacuum process, as indicated by the size of the mixing vessel and by the speed of rotation of the shaft carrying the mixing blades, as I observed that speed, would not, from the standpoint of my experience and observation, be sufficient to cause the agitation which we have found to be necessary in producing the agitation froth.

185 X Q. Explain, if you can from your expert knowledge, why the speed of rotation of the agitator used in the Elmore vacuum process or in the process practised by Minerals Separation, has anything to do with the introduction of air into the pulp.

A. The answer to this would be, of course, a theoretical

96 conclusion, but we have observed in the operation of Minerals Separation process that agitation of considerable vigor, such as would be represented by the agitation produced by agitating blades of, say, twelve or fourteen inches in diametrical length, rotating at a speed in the neighborhood of 400 revolutions per minute, is necessary to produce good agitation froth results, and as it is a reasonable theory that these results are produced by the beating of air into solution more or less, I would not expect that the relatively slow speed of the mixer blades in the Elmore mixing vessel would have much effect in so beating air into solution.

186 X Q. Did you ever determine by actual tests or experiments whether a pulp contained more air in solution or in the form of bubbles after agitation of the degree referred to than before?

A. In an ore pulp the mineral content is usually such as to obscure the results from the standpoint of observing them along the line which you have described. I have made tests on a solution of water and a small amount of a frothing re-agent or of oily matter, such as oleic acid, eucalyptus oil, etc., with and without sulphuric acid, wherein this water has been agitated vigorously and the appearance immediately after agitation has ceased was such as to indicate that a great deal of air had been introduced into the solution as bubbles or otherwise as a result of the agitation. There were also indications in some of these tests that the air was actually driven into solution in the water.

97 187 X Q. In these tests or experiments which you have referred to in your last answer, did you observe the particular degree of agitation necessary to introduce air in the way you have described?

A. Yes.

188 X Q. What was the minimum degree of agitation necessary to produce that result?

A. This result is affected very largely by the kind of oily matter or frothing re-agent used. I do not recollect having made any speed determinations or estimates which would indicate to me with any particular frothing re-agent the lower limit of speed at which this frothing effect begins. I have merely made tests indicating that, in the case of the small testing machines which are used, rather a high speed, such as a speed in the neighborhood of 1,000 revolutions per minute or more is necessary to get a strong emulsifying effect.

189 X Q. I understand from one of your previous answers that in operating upon a pulp, that is, water holding pulverized ore in suspension, it is impossible by visual observation to determine the time or extent of the introduction of air, and that in your experiments with water not containing ore, but containing only the frothing re-agent, you made no observation of the speed necessary to introduce air, the introduction of air in the latter case being visible to the eye. Is this correct?

98 A. My previous answer was that the mineral matter in suspension obscured the results from the standpoint of observing directly the amount of air introduced into the ore

pulp. I would not say that this ore rendered visual observation impossible, as it is usually possible to observe in some degree with the proper apparatus as to whether or not air has been introduced. As to the second part of your question, I made no exact determinations or estimates of the speed necessary to introduce air into water containing a frothing re-agent. I have merely observed in a general way that rather vigorous or violent agitation produces the strongest emulsifying effect.

190 X Q. By emulsifying effect do you mean the breaking up of the oil and oleic acid into small particles held in suspension in the water?

A. By emulsifying effect I refer to an effect which indicates itself by a milkiness in the solution due to the existence of minute air bubbles and to frothiness at or near the surface of the liquid. In these experiments it has appeared that the oil, such as oleic acid or eucalyptus oil, has become broken up into small particles which are probably distributed in large degree throughout the liquid.

191 X Q. Do you mean that the agitation of the liquid containing the oily matter simultaneously produces these two effects, namely, the breaking up of the oily matter into small particles forming an emulsion thereof, and the introduction of more or less minute air bubbles?

99 A. As this emulsifying effect is greatly influenced by the presence of the oily matter, it would be, I think, a fair inference that the oily matter was first broken up and distributed throughout the water before the emulsification became pronounced and I would so understand it.

192 X Q. Is there some indication in these operations that the oil is broken up into fine particles and distributed before any air is entrained in the liquid by the agitation?

A. The entraining of air, that is, the drawing of air below the surface of the liquid, begins, according to my observation, as soon as the speed of agitation is sufficient to give a broken surface to the water. At what instant actual emulsification begins after the air has begun to be entrained, I could hardly say. In regard to the breaking up of the oil, I should think that would begin almost immediately after the agitation became sufficient to break the water surface, assuming that the oil was floating on the water surface before agitation began.

193 X Q. Then the breaking up of the oil into the form of an emulsion and the drawing of air into the liquid begin, according to your observation, about the time that the agitation becomes sufficient to break the surface of the liquid. Is that correct?

A. As the amount of oil used is very small, one loses sight of it as soon as the water begins to move and it would be only an inference that these effects were simultaneous.

100 194 X Q. Is it your judgment, as an expert in this art, that the inference is substantially correct that the breaking up of the oil and its distribution through the liquid, as well as the drawing of air into the liquid, both begin at the time the surface of the liquid is broken by the agitation?

A. When the oil is floating on the surface, yes.

195 X Q. And the oil does tend to float on the surface when added to water by being fed to the surface thereof, does it not? Or when fed anywhere in the mass of the water, for that matter?

A. Yes, usually; though I have observed cases where impure oil, for some reason or other, was heavy enough to sink.

196 X Q. The use of such impure oil as will sink is an unusual occurrence, is it not?

A. In the flotation froth process, yes.

197 X Q. In the process which you have termed the Cattermole process, the introduction of air into the pulp being treated would have what sort of an effect upon the mode of separation desired in that process?

A. So far as my observations have gone, which I have already indicated are very limited, the introduction of air had practically no effect upon the mode of separation desired.

198 X Q. In the Elmore vacuum process, assuming, according to the belief which you have stated, that the agitator or mixing blades are only partially submerged in the pulp in the mixing trough and are then rotated at a speed of 60 or 70 revolutions per minute,
101 is it your judgment as an expert that the surface of the pulp would be broken?

A. Necessarily, yes; as it would be broken each time a blade entered that surface.

199 X Q. Then does it not seem reasonable to assume that some air would be drawn into the pulp at this stage of the Elmore vacuum process, and that the pulp upon entering the U-shaped tube would contain more air than it did before entering the mixing trough?

A. It would be reasonable, I think, to assume that at this stage of the Elmore vacuum process some air might be entrained and carried below the surface of the ore pulp as bubbles of air, but I am confident the effect of this would not be the same as it would be with more violent agitation; also, if I recollect correctly, the pulp is not introduced to the U tube of the vacuum machine before having a chance to flow through a short open passage, which it would seem to me would tend to reduce, perhaps wholly reduce, by allowing these bubbles to escape, the amount of air introduced into the ore pulp in this way.

200 X Q. In your description of the operation of the Minerals Separation, Limited, testing plant in London, you referred to the heating of the solutions in those cases in which heat was necessary. Were there instances in which heat was not necessary in the practice of the flotation process in that plant?

A. Yes.

102 201 X Q. Can you define the conditions under which heat was necessary as distinguished from those when it was not necessary?

A. It has been our general experience that, in the treatment of ores by the agitation froth process, the results are much better on ores containing zinc sulphide, for instance, with a rocky gangue, such an ore, in fact, as that produced by the Butte & Superior Copper

Company, when the ore pulp is heated above atmospheric temperature than when it is not. There are some other ores, of which a good example is an ore containing untarnished or unoxidized particles of the mineral chalcopyrite, on which good results are obtainable at atmospheric temperatures with some special re-agents.

202 X Q. Then I take it that this matter of temperature is not one upon which any general rule can be laid down, but is simply a question of trying different temperatures and adopting the temperature which seems to give the best result. Is that correct?

A. Not exactly. It can be practically laid down as a general rule that ores containing zinc sulphide with a rocky gangue, such as in the instance I have cited, give better results at temperatures above ordinary atmospheric temperatures.

203 X Q. You would apply this general rule then to such ores as are worked by the Butte & Superior Copper Company, but would forget your rule when you encountered some mine operating upon a chalcopyrite ore, such as you have just referred to. Is that correct?

103 A. Not exactly. I would apply this general rule to ores similar to the ore of the Butte & Superior Copper Company, and I would make another general rule that chalcopyrite ores, where the chalcopyrite is fresh and unaltered, would yield good results with certain special re-agents at atmospheric temperatures.

204 X Q. As I understand your explanation, you have some general rules which only apply in particular cases. Is that the extent of the generality you can make on the subject of heat as used in the flotation process?

A. I can perhaps make my meaning clearer by giving our ordinary methods of testing ores in regard to this point. When an ore containing zinc sulphide in a rocky gangue comes to us to be tested, we make our tests initially and as a matter of course at temperatures above the atmosphere. When an ore containing the mineral chalcopyrite and a rocky gangue comes to us to be tested, we make our tests at the ordinary temperature of the tap water, as a matter of course.

205 X Q. Do you in the practice of the froth flotation process use heat in operating upon ores or earth containing graphite?

A. I have never made or supervised any tests on ores or earths containing graphite, with the froth flotation process, and I am uncertain as to what conditions would yield the best results on such an ore or earth.

206 X Q. Have you ever seen any instructions on the subject whether heat would be necessary in operating on an ore
104 containing graphite for the purpose of separating graphite by the froth flotation process?

A. I do not recollect having seen any such instructions, though there was some discussion of flotation processes as applied to graphite in the material furnished to me when I went to Australia.

207 X Q. Would you use a degree of heat higher than ordinary atmospheric temperature, say 70° Fahrenheit, in treating by the

froth flotation process an ore containing ferruginous blende, galena and a gangue consisting of quartz, rhodonite and garnet?

A. The first step in treating such an ore would, of course, be to test it on a small scale, and in such a small scale test I would begin by using a degree of heat higher than that you have mentioned.

208 X Q. Was the ore which you saw treated at the plant at South Wales submitted by the San Francisco del Oro mine?

A. I understood that it was.

209 X Q. Have you any information as to whether the results secured by the tests in South Wales of this ore were satisfactory to the managers of the San Francisco del Oro mine?

A. Not definitely.

210 X Q. You have no personal knowledge, have you, to the effect that the tests at the South Wales plant were satisfactory to the San Francisco del Oro management?

A. I have no personal knowledge on this point.

105 211 X Q. Have you any personal knowledge as to the adoption of the process as witnessed by you in South Wales by the San Francisco del Oro mine?

A. I have no personal knowledge on this point.

Adjourned to Monday, February 19, 1912, at 10:30 A. M., at the same place.

New York, February 19, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Mr. Nutter continued:

212 X Q. Assuming that labor cost $3.50 a day, coal $5.00 per ton, sulphuric acid 1½ cts. per pound, red oil or impure oleic acid 6 cts. per pound, and that fifty per cent. concentrates are worth one cent per pound net at the works, about how low grade an ore could be made to yield a profit by the froth flotation process as practiced by Minerals Separation, Limited? You may base your answer upon such an ore as that occurring in the mine of the Butte & Superior Copper Company.

A. The data as given in the above question is not sufficient to make an exact estimate of the grade of ore which it would be possible to treat by the flotation froth process, as no base price of spelter is mentioned, as no variation in price of concentrate for variation in grade from a concentrate assaying fifty per cent. zinc is men-

106 tioned, the recoveries would have to be assumed and all of these factors would affect the final result.

213 X Q. What is your judgment, from your knowledge of the art, in regard to the percentage of recovery and the percentage of zinc in the concentrates that would be obtained from the Butte & Superior ore by the application thereto of the flotation process practised by Minerals Separation, Limited?

A. My judgment of what the treatment possibilities are on the Butte & Superior ore is necessarily based on the results of some small scale experiments made under my supervision on some samples of ore which were shipped to me from Butte and Basin, Montana, by persons connected with the Butte & Superior Company, and purporting to be samples of ore from the Butte & Superior mine. On the basis of tests on these samples, reports of which bear the date of 10th and 11th of May, 1911, it would be my judgment that a recovery of ninety-five per cent. or better of the zinc values in that ore in a concentrate assaying fifty-one per cent. zinc or more, would be entirely reasonable to expect by the application of Minerals Separation froth process.

214 X Q. In prior practice upon the commercial field, has a recovery of ninety-five per cent. ever been secured?

A. In prior practice, so far as I am acquainted with it, the material treated was in many ways different from the Butte and Superior Copper Company's ore and on a commercial scale such recov-
107 eries have not, to my knowledge been obtained. I base my answer, however, upon the relationship which we have found to exist between results obtained in the small scale machines, such as the tests referred to were made in, and the commercial apparatus working on the same material.

215 X Q. Do you know who first developed and used this small scale testing machine to which you have referred?

A. Not of my own knowledge.

216 X Q. In prior operations upon a commercial scale with the flotation process as practised by Minerals Separation, Limited, have concentrates been secured in the case of zinc ores running as high as fifty-one per cent. zinc, referring to operations running over any considerable length of time, as distinguished from a momentary occurrence?

A. Not to my knowledge.

217 X Q. In treating ores by the process practised by Minerals Separation, Limited, is the practice in any way modified or affected by the presence in the ore treated of carbonates?

A. Sometimes.

218 X Q. In what manner does the presence of carbonates affect the application of the process practised by Minerals Separation for the flotation of sulphides?

A. It depends on the ore being treated.

219 X Q. In what way does it depend on the ore being treated; that is, what are the other considerations besides the presence
108 of carbonates that enter into the matter?

A. The presence of carbonates in an ore usually make for a higher consumption of acid than would be the case if they were not there. In an ore, therefore, in which carbonates occur, if it should be found necessary to use acid, such an adjustment of conditions and apparatus would be advisable as would minimize the expense incident to any chemical reaction between the acid and the carbonate in the ore.

220 X Q. I presume the principal adjustment of conditions and

apparatus that you refer to would be an adjustment of the amount of acid to meet the requirements; would it not?

A. It might easily be found possible to remove to a considerable degree prior to the application of the flotation process the carbonate from the ore, which would have the effect of reducing the acid consumption and also it would probably be found advisable to operate the flotation froth process at as low a temperature as gave good results. The whole matter is one of balancing costs and of using such a modification of the process as yielded the best net result from a standpoint of profit.

221 X Q. Why is it that the presence of carbonates in the ore increases the amount of acid necessary to be used in those cases in which acid is used in the flotation process?

A. The answer to this is a theoretical conclusion, but it
109 seems reasonable to believe that, if in an ore in the treatment of which it is found necessary to use acid for the effect which that acid has upon the formation of a froth, and if in that ore there is a carbonate which reacts with the acid, the effect of the acid upon the formation of a froth might not become evident until the chemical reaction with the carbonate has been more or less completed. There would then, in such a case, be the amount of acid required to produce the froth and the amount of acid required to satisfy the chemical reaction with the ore, which would mean, of course, that a larger amount of acid would be necessary than in the treatment of an ore containing no carbonate or other acid-consuming mineral.

222 X Q. One of the products of the reaction between sulphuric acid and a carbonate is carbon dioxide gas, is it not?

A. So I believe, yes.

223 X Q. Under the circumstances set forth in your answer to X Q 221, this carbon dioxide gas would be introduced or liberated in the ore pulp; would it not?

A. I think so, yes.

224 X Q. And this carbon dioxide gas so liberated in the pulp would, as in the Elmore vacuum process to which you have referred, contribute to the flotation of the oil coated sulphide particles?

A. Not necessarily.

225 X Q. Will you explain your answer a little more fully, stating why carbon dioxide gas liberated in an oiled pulp under the conditions prevailing in the practice of the flotation process would not contribute to the flotation effect?

A. I have observed in experiments that at times the result of add-
ing sulphuric acid to an ore pulp containing carbonate was to
110 not form a froth of any permanence or stability. In fact, such a froth would not form until the reaction with the carbonate had ceased, although there was a considerable production of what I took to be carbon dioxide gas, and I was unable to get a froth of any permanence or stability, until I had added sulphuric acid in excess of the amount necessary to satisfy the carbonate.

226 X Q. Having added such excess of sulphuric acid over and above that necessary to satisfy the carbonate, the flotative effect then secured was still probably caused in part, was it not, by the carbon dioxide evolved from the carbonate?

A. I would not think so.

227 X Q. Suppose in the test which you described as making in a bottle by placing therein water, oil, acid and an ore containing carbonate, and then shaking the bottle, producing a froth, would you consider that the existence of that froth was due in any measure to the carbon dioxide gas resulting from the action of the acid upon the carbonate?

A. In such a test, wherein the carbonate was present in insufficient quantity to react with all the acid chemically, but was still there in quantity sufficient to produce some carbon dioxide, it would be reasonable to believe that the carbon dioxide had contributed in some measure to the formation of the froth, assuming that a froth was formed.

228 X Q. And the same thing would be true, would it not, in the case of carbon dioxide gas evolved in the pulp during the commercial application of the process?

111

A. Not necessarily.

229 X Q. Will you explain why there is a difference, if that is your meaning, between the action of carbon dioxide gas in a bottle and in the apparatus used in the commercial practice of the process?

A. I can easily conceive that there would be a difference in the effect of the carbon dioxide in these two cases on account of the difference in treatment which is given in a commercial plant as compared with the treatment in a bottle, as the carbonic acid gas formed might escape from the pulp before the pulp had reached that part of the apparatus where the froth was formed.

230 X Q. Considering again this bottle test, in which sulphide ore, a mineral acid, oily matter and water are shaken in a bottle, the ore containing no carbonate whatever, what is it that produces the froth or bubbles?

A. Apparently the shaking of the bottle under these conditions.

231 X Q. And how does the shaking of the bottle bring about this result?

A. Presumably by the rather violent agitation of the pulp mixture.

232 X Q. This violent agitation of the pulp mixture in the bottle has what detailed effect that results in the promotion of the frothing effect? That is, why is it that agitation of the contents of the bottle in the absence of any matter which gives off gas by chemical reaction, assists in producing a froth?

112

A. Presumably by the aeration of the pulp, which results from the agitation.

233 X Q. That is, the shaking of the bottle and agitation of its contents brings about the introduction of air bubbles in the pulp contained in the bottle?

A. It probably brings about the introduction of air into the pulp in such a way as to result in a froth being formed.

234 X Q. Are you familiar with any zinc ores carrying a carbonate or carbonates, in the treatment of which upon a commercial scale the use of acid has been unnecessary? I refer to the flotation process as practised by Minerals Separation, Limited.

A. No.

235 X Q. About what amount of acid is used in the commercial

treatment of zinc ores by the flotation process practised by Minerals Separation, Limited?

A. The amount used varies with different ores.

236 X Q. Give some examples of the different amounts used with different ores.

A. As I have stated previously, the only commercial plants which I am familiar with are those treating the zinc lead silver ores in Broken Hill, New South Wales. In the treatment of some of
113 those ores, my recollection is that the amount of sulphuric acid used was from fifteen to twenty-five pounds per long ton of crued ore, the long ton being 2,240 tons.

237 X Q. What oily re-agent was used at Broken Hill?

A. Druing the time I was there the plants were running part of the time with oleic acid, part of the time with amyl alcohol or fusel oil, and part of the time with eucalyptus oil.

238 X Q. Can you form any judgment, as an expert in this art, as to what the effect would be of the presence of lime, that is, calcium hydroxide, in a pulp which was being subjected to the flotation treatment as practised by Minerals Separation, Limited?

By Mr. Williams: Objected to as not warranted by the direct examination, irrelevant and immaterial. It is submitted that there should be some limit to the extent to which a defendant may anticipate possible theories of his own which form part of his defense by cross-examination under the guise of testing the qualifications of the witness.

A. It would depend on the particular variation of the flotation treatment which was ordinarily necessary for that ore.

239 X Q. Have you any knowledge, based upon your experience, which will enable you to form any judgment as to the effect of lime in the pulp under any of the conditions which your last answer contemplates?

114 By Mr. Williams: Same objection, and it is stipulated that this objection shall be continued without repetition to this line of cross-examination.

A. I have had performed under my supervision some tests in which lime may have been present, but, as other conditions were varied at the same time, I would not be sure as to the effect which the presence of the lime itself had.

240 X Q. What finally becomes of the air which is entrained into the pulp during the agitation which forms part of the flotation process?

A. This is a theoretical conclusion. Presumably some of it goes to form the froth and some of it escapes without forming a froth.

241 X Q. I presume it is possible that some of the air goes into solution in the water of the pulp, and that some of the air so dissolved is subsequently liberated. Would that be your judgment?

A. Yes, that seems a reasonable belief.

242 X Q. In your testimony you have frequently referred to the flotation froth process or the agitation froth process of the Minerals

Separation, Limited. Will you give a definite description of the process to which you refer by these expressions?

A. I would refer you to my answer to 40 X Q as a reply to this question, but I am willing to supplement that answer in any way you desire.

115 243 X Q. In your answer to the question above referred to, you seem to have based your description of the process upon its application to the ore of the Butte & Superior Copper Company. Would the same description apply to the treatment of the ores at Broken Hill, New South Wales?

A. Yes.

244 X Q. Did the process as described in the answer to 40 X Q. apply successfully to the San Francisco del Oro ores?

A. I have no knowledge of my own as to the commercial success of the tests made on the San Francisco del Oro ore in South Wales to which you refer. In general, the process which I described was the process by which that ore was tested.

245 X Q. In treating an ore by the flotation process practised by Minerals Separation, Limited, assuming, of course, that the ore is one adapted to yield results from such process, what would be your judgment, as an expert in this art, upon the question as to whether the results would be better or worse with the pulp heated to 100° than with the pulp heated to 90° Fahrenheit?

A. It depends on the ore being treated. Some ores work best with some frothing agents at a lower temperature than 90° F. and some ores work best with some frothing agents at a higher temperature than 100° F.

246 X Q. Assume that the process is being applied to the
116 ore of the Butte & Superior Copper Company and that red oil or impure oleic acid is the oily matter used, would it be your judgment that the process would yield better results at 100° than at 90° Fahrenheit?

A. Yes, and it might yield also still better results at a temperature above 100° Fahrenheit.

247 X Q. Do you think the improvement in results would continue with an increase in temperature up to 110° Fahrenheit?

A. Yes.

248 X Q. Do you think the improvement in results would accompany the increase in temperature up to 120° Fahrenheit?

A. They might easily do so, yes.

249 X Q. Do you think that the improvement in results would continue with a temperature above 120°?

A. It has been my experience in testing and working on such an ore as that of the Butte & Superior Copper Company, that there is an upper limit of temperature beyond which practically no commercial improvement takes place, and that, if the ore pulp is heated beyond this temperature, it merely means an added expense and possibly poorer results than could be obtained at a lower temperature. In the tests which have been made under my supervision on the Butte & Superior ore, the particular point of determining the best

temperature was not gone into, though we got good results above 120° Fahrenheit.

250 X Q. In your reply to 63 X Q., you stated that you had
117 read the patent granted to Carrie J. Everson. I show you United States patent 348,157, granted to Carrie J. Everson, August 24, 1886, that is a printed Patent Office copy thereof, and ask you whether that is the Everson patent to which you referred (Mr. Scott shows copy of patent to witness).

By Mr. Williams: The objection stated to 63 X Q. is repeated.

A. Yes.

251 X Q. In the application of the flotation process as practised by Minerals Separation, Limited, are there any differences in mode of procedure or quantity used in the case of thin oils and more viscous oils?

A. There are usually obtainable different results from the use of different oils and, of course, different oils have different degrees of viscosity, but as to whether or not the differences in results are obtainable as a result of the differences of viscosity, I have no knowledge of any data bringing out this exact point.

252 X Q. My question was directed more particularly to ascertain whether, when a thick or viscous oil was used, the other conditions of the process have to be adjusted differently as compared with the adjustment existing when a thin oil is used. Will you answer the question with that explanation? For instance, when a thick or viscous oil is used, is the amount of acid, the degree of agitation and temperature the same as when a thin oil is used?

118 A. The answer to that question is a bit difficult to make, as other conditions are introduced by the use of different oils, besides differences in viscosity, and it is hard to say whether or not the differences in viscosity had any effect which necessitated variations in adjustment, as you have indicated.

253 X Q. About what was the proportion of water to ore in the pulp which you saw treated by the flotation process as practised by Minerals Separation, Limited, in Australia?

A. My recollection is that the proportion was about four of water to one of ore by weight, though I did not make any determinations as to this proportion.

254 X Q. Which is the more viscous, impure oleic acid, sometimes called red oil, or eucalyptus oil?

A. Impure oleic acid.

255 X Q. Is there any difference in the quantity of these two oils which is necessary for the treatment of ores by the flotation process as practised by Minerals Separation, Limited?

A. To the best of my belief, yes.

256 X Q. Which of the two oils is used in the larger quantities?

A. To the best of my knowledge, more oleic acid per ton of ore is required as compared with eucalyptus oil to get the same result.

257 X Q. Would more or less red oil, sometimes called impure oleic acid, be necessary in operating the flotation process as

119 practised by Minerals Separation with the pulp at 60° Fahrenheit, or with the pulp at a temperature of 120° Fahrenheit?

A. I have not made any tests tending to illustrate this point one way or another.

258 X Q. Do the results secured by the operation of the small testing machine which you have referred to correspond in all respects with the results obtained upon the same ore, with the same proportions of the different ingredients and at the same temperature when operating with the apparatus used commercially?

A. There is usually a fairly definite relationship which we have found to exist between the results obtained with the small scale machine as compared with the results obtained with a commercial apparatus operating under like conditions of temperature and approximately the same proportions of the different ingredients.

259 X Q. As I understand your answer, there is not an identity of results between the process as carried on in the test machine and in the commercial apparatus, other conditions being as nearly the same as they can be made?

A. The results are not identical; no.

260 X Q. Will you describe the small test machine to which you have referred, or, if you have had more than one sort of test machine in mind, please describe all of them?

A. There are two types of small test machines which we
120 have used in the testing of ores by the flotation froth process; both of them, however, operate under the same general principles and in general in the same way. The differences are differences of detail for convenience in handling the tests. One of these is known briefly as the slide machine. It consists of a hollow metallic box, divided midway about from the bottom when it is standing with the closed end downward and so arranged that the upper half can be removed or slid with reference to the lower half along a slide which forms a part of the machine. In the bottom of the lower half there is what is called an impeller, which is used for agitating the ore pulp mixture, and which is driven at rather a high speed by a shaft coming up through a stuffing box in the bottom. The box or agitating chamber has a square cross-section. In one side of this square metallic box there are two small panes of glass inserted and forming a part of that side to enable the appearance of the test to be observed. One of these panes is above and the other below the plane of division. In one corner of the bottom of the box there is an outlet valve for conveniently removing the ore pulp remaining in the lower half of the machine after a test is completed. The agitator shaft or spindle carries a small pulley on its lower end below the metallic box, which pulley is rotated by a belt from some convenient source of power.

In the other testing machine, the agitation chamber is similar in
121 appearance to a large, round glass bottle with the bottom removed and with the end which usually carries the cork downward. This bottle has arranged in it baffles for breaking up the swirl of the pulp being agitated, which gives a more violent agitation. The agitation in such a machine is usually performed by an impeller rotating near the cork end of the inverted bottle and carried

on a shaft or spindle introduced into the pulp from above, which is driven by some convenient source of power. The opening in the bottom of the bottle is used for drawing off the ore pulp mixture after a test is completed. In this machine the concentrate is removed by skimming it off from the surface of the liquid with a spoon or otherwise, while in the other or slide machine the concentrate is removed by forming it above the line of division of the two parts and by sliding the upper part relative to the lower part. This last action cuts the top of the ore pulp mixture off, as it were, and with it the froth which has been allowed to rise to the surface.

261 X Q. Have you seen any other form of small testing machines for use in testing flotation processes?

A. It is my recollection that there were a number of different types of machines in the London testing works that had been used at different times, but I never observed them carefully.

262 X Q. Which of the two machines you have described in answer to 260 X Q were used by you in the various tests to which you have referred in your testimony?

A. The tests which I witnessed in Australia with a small
122 machine were made with the type consisting of a bottle with the bottom cut off. The other tests were made with the slide machine.

263 X Q. In the boxes or spitzkasten which you have seen in commercial operation in the practice of the flotation process, as practised by Minerals Separation, Limited, was an up-current of water maintained in these spitzkasten? That is, an up-current of water, not a portion of the pulp being treated?

A. I assume in my reply that you refer to the spitzkasten on the surface of the liquid in which the flotation froth has formed. In these spitzkasten there were no such up-currents to my knowledge.

264 X Q. In the apparatus which you have seen in commercial operation in the practice of the flotation process as used by Minerals Separation, Limited, was the pulp after agitation conducted in a thin layer to a trough or over an apron between the mixing or agitating box and the box in which the froth was permitted to form?

A. My recollection is that the connection between the agitating box immediately preceding any given separating box was a hole in the dividing partition between them.

265 X Q. This hole, of course, being below the surface of the pulp?

A. Yes.

266 X Q. In referring to the Elmore vacuum process, you stated that, in your judgment, any air which might be entrained
123 in the pulp by the action of the agitator or mixing blades in the mixing trough would be likely to escape before the pulp reached the U tube by reason of the fact that the pulp passed through an open trough. Would not a similar action be likely to take place in the process practised by Minerals Separation, Limited, if the pulp were allowed to pass from the agitating box in the form of a thin layer exposed to the atmosphere in its passage to the separating box?

A. Not necessarily, as it has been my observation that air can be

bubbled into or through an ore pulp without giving any flotative effect, and it would be my belief that the bubbles entrained by the relatively slow moving blades in the mixers in the Elmore vacuum process would act in a similar way to bubbles blown into the pulp. With the agitation froth process, however, it would seem reasonable to expect that, if the pulp passed through such an open launder as you describe, the bubbles in coming to the surface of the pulp would come to the surface as a flotation froth and not escape into the air.

267 X Q. Is the flotation process as you have seen it practised by Minerals Separation, Limited, was the pulp at any stage of the process conducted into chambers and subjected to the action of air at a higher pressure than atmospheric pressure?

A. No, I never saw this tried.

268 X Q. Referring to "Complainants' Exhibit, Nutter Drawing of Defendant's Plant, Sheets 1 and 2," at the time you were
124 in the plant or in its neighborhood, did you see anything taking place in the part which you have designated on Sheet 1 as launder A?

A. No.

269 X Q. In what form was the ore which you saw supplied to the Basin plant?

A. As I recollect it, the ore was supplied to the flotation plant as a wet ore pulp or mud.

270 X Q. Did you see ore supplied to the plant in any other form than as this mud?

A. Not to my recollection.

271 X Q. Did you see acid supplied to the material being treated?

A. No.

272 X Q. Did you see oil being supplied to the material being treated; that is, oleic acid or oily matter of any kind?

A. No.

273 X Q. What means did you use, if any, in estimating the speed of rotation of the agitators?

A. The appearance only.

274 X Q. This pulp which was supplied in the form of a mud was not what would be termed a free flowing pulp, was it?

A. Not up to the time it entered the flotation apparatus.

275 X Q. It was wet, however, was it not, that is a sort of mush or mud?

A. As I recollect it, yes.

125 276 X Q. From your knowledge of this art, would you say that sulphuric acid as used in the flotation process practised by Minerals Separation, Limited, has any effect in the way of increasing the selective action of the oily matter for sulphides as distinguished from the gangue or other part of the ore?

A. In general, yes, though there are some ores on which we find it unnecessary to use sulphuric acid.

277 X Q. What was your purpose in going to Basin, Montana, in August, 1911, at the time you visited the Basin plant which you have referred to?

A. To corroborate the information which I had to the effect that

Mr. Hyde was infringing my Company's processes and to test whether or not that information was true.

278 X Q. Was your meeting with Mr. Hyde, at the time he refused to permit you to enter the Basin plant, the only time you met him upon this visit?

A. We spent most of the time between trains in each other's company.

279 X Q. Between what trains?

A. Between the time of arrival of the train on which I went to Basin, and the time of departure.

280 X Q. Did you arrive and depart on the same day?

A. Yes. I got there shortly after the middle of the afternoon, as I recollect it, and departed about nine o'clock that evening.

281 X Q. Did you have dinner at Basin with Mr. Hyde before you left?

126 A. Yes.

282 X Q. Did you return to Basin that same evening?

A. No.

283 X Q. Was it the next day that you came back?

A. The first visit I made to Basin, when Mr. Hyde refused me admission to the plant, was on August 8. The next visit, when I went in and inspected the plant, was on August 10.

284 X Q. Where did you and Mr. Hyde have dinner on this evening of August 8th?

A. At his house.

285 X Q. How did it happen that you had dinner at his house?

A. Mr. M. W. Atwater and I were together and he invited the two of us and the mill superintendent of the Basin mill.

286 X Q. Where did you go when you left Basin on the night of August 8th?

A. Back to Butte, Montana.

287 X Q. What are the relative positions of Butte, Basin and Helena, Montana?

A. In general, Helena is in a northerly direction from Butte and Basin is on the railroad connecting Butte and Helena, and I think in a general northerly direction from Butte.

288 X Q. Is Basin between Helena and Butte?

A. By railroad, yes.

289 X Q. What was this south-bound train that you rode

127 on when you went to Basin on August 10th, 1911; a regular schedule passenger train?

A. I believe there was a regular schedule passenger train running from Helena to Butte and stopping at Basin.

290 X Q. What time does this train leave the point where you boarded it?

A. I boarded it at a point between Basin and Helena, as I remember some time between eight and nine o'clock in the evening, or thereabouts. It was the same train or a train operating on the same schedule, as I remember it, as the one I left on when I went from Basin to Butte at the time of my other visit. I had pre-

viously gone earlier in the day of this second visit from Butte to a point between Basin and Helena.

291 X Q. What was your purpose in going earlier in the day to this point between Basin and Helena?

By Mr. Williams: Objected to as not warranted by the direct examination, and altogether irrelevant and immaterial, as well as incompetent.

A. I went to this other point for the purpose of stopping off between trains and seeing another man on a matter of other business.

292 X Q. As I understand it, you passed through Basin on the way from Butte to this point between Helena and Basin where you went to see this other man?

A. Yes.

128 293 X Q. I understand that it was on the morning of August 11, after your visit to the Basin plant, that you left Basin for Helena. At what hour did this train leave which you took from Basin to Helena on the morning of August 11?

A. Rather early in the morning, as I remember it; about nine o'clock.

294 X Q. After you had finished your business in Helena upon arriving there from Basin on August 11, 1911, where did you next go?

A. I went back to Butte.

295 X Q. You had no business in Helena, had you, other than preparing the drawing which you have referred to in your testimony and sending the bottle containing the concentrate which you say you took from the mill at Basin?

A. I did not prepare the drawings I have referred to in Helena, as I believe that I have stated previously that they were prepared in Butte upon my return there from Helena. Yes, I did have other business in Helena besides that of sending the bottle containing the concentrate which I took from the flotation plant at Basin.

296 X Q. When you saw Mr. Hyde upon the occasion when he refused to permit you to enter the plant at Basin, did he not tell you that, while he would not permit you to enter the plant, he would be perfectly willing to permit an investigation by an impartial officer of the court if any legal procedure existed for such an arrangement?

129 A. My recollection is that he said something of this sort.

297 X Q. Did not Mr. Hyde also state to you that the operations in the Basin plant involved new operations which he had invented and which he desired to keep secret?

A. Yes.

298 X Q. You have stated that, when you met Mr. Hyde at the Basin plant, you told him that you knew he was operating a flotation plant in infringement of your Company's patents. Did you really know this or think you knew it?

A. From the information which I had I felt sure of it.

299 X Q. Did you not tell the shift foreman of the Basin plant

that he need not fear getting in trouble about your admission to the plant, as you would get him a better job if he lost the position he was holding?

A. After I had left the plant and had secured the sample of concentrate which I have referred to, I have stated that this shift foreman followed me down the railroad track. He asked me to surrender the sample, which I refused, and then he asked me to go with him to Mr. Hyde's house and explain to Mr. Hyde what I had done, which I refused. He expressed some anxiety as to the effect upon his position of my visit to the plant and taking a sample away; in fact, seemed to be considerably worried as to the possibility of losing his job. As he had acted altogether in a praiseworthy man-
130 ner from the standpoint of his employers and seemed to be a man of a good type, I made up my mind that, if he lost his job as a result of what I had done, I would take care of him and give him one myself, and I told him so.

300 X Q. Do you know the mineralogical composition of the ore of the Butte & Superior Copper Company's mine?

A. In a general way, yes.

301 X Q. Will you please state the mineralogical composition of that ore?

A. As I recollect it, the ore contains sphalerite, or perhaps it may be the variety marmatite, at any rate zinc sulphide, some galena, a little copper sulphide in some parts of the mine, I understand, quartz, and various silicates. There may be other minerals than these in the ore, but I do not recollect them at present.

302 X Q. Is not manganese carbonate an element of the Butte & Superior ore?

A. I have been told there is manganese carbonate in the ore.

303 X Q. What did you actually find yourself in the Butte & Superior ore?

A. I had in mind the zinc sulphide ores with what is called a silicious gangue, such ores as have zinc for their chief valuable mineral. is hearsay. I recollect seeing a pink mineral underground, which I was told was manganese carbonate and which may have been such.

304 X Q. Was this pink mineral abundant?

131 A. As I recollect it, the distribution of it was rather spotty; some stopes containing it in some quantity and others not.

305 X Q. Have you any knowledge as to the proportion of the different minerals which you have mentioned are present in the Butte & Superior ore?

A. Hearsay information only.

306 X Q. In the references which you have made in your testimony to such ores as the Butte and Superior ores, did you have in mind these sulphide ores generally or, if not, what did you have in mind?

A. I had in mind the zinc sulphide ores with what is called a silicious gangue, such ores as have zinc for their chief valuable mineral.

307 X Q. Would the presence in an ore of considerable quantities of kaolinized feldspar interfere with the classification of that ore as one having a silicious gangue?

A. The presence of kaolinized feldspars, or clayey matter, in an ore would have some effect upon the classification given to the ore for any particular purpose undoubtedly; but whether it would act as an interference with the classification would depend upon the results aimed at by the classification. I have used the term classification as meaning hydraulic classification; that is to say, the separation of a crushed or pulverized ore into different portions by means of the different rate of settlement in water of different mineral particles, this being its ordinary use in referring to ore treatment.

132 308 X Q. The question does not refer to ore treatment, but is intended to elicit your judgment as to whether an ore containing a considerable quantity of kaolinized feldspar would properly be called a silcious ore.

A. It might be termed with propriety a clayey ore, but as kaolin is a silicate mineral such an ore could with equal propriety be termed an ore with a silicious gangue. In general parlance, the term silicious gangue is used to distinguish between ores having a gangue of silicate minerals and an ore having a carbonate gangue, such as limestone.

309 X Q. In the language of metallurgy or mineralogy is not the term silicious confined to ores containing silica as distinguished from ores containing clayey bodies, irrespective of whether such clayey bodies are silicates or not?

A. In general I think that the designation is used to indicate the predominant gangue mineral. If an ore had a large quantity of clay consistently throughout, it would probably be referred to as a clayey ore with quartz in it if silica were also present as quartz in any substantial quantity. If the predominant mineral was quartz or any other non-clayey silicate, such as unkaolinized feldspar, I think it would in general be termed a silicious ore.

Cross-examination closed.

133 Redirect examination.

By Mr. Williams:

310 R. D. Q. I do not quite understand your answer 290 X Q. Will you please state just what you meant in that answer?

A. The train referred to there is, as I remember it, a train running south from Helena to Butte, stopping at the different points between these stations. It was the train on which I returned from Basin to Butte at the time — my visit there on August 8. At the time of my visit on August 10th, I had previously gone to a point north of Basin, and when this train came along I boarded it and went on it to Basin where I got off, about nine o'clock in the evening, as I remember, or it may have been somewhat earlier.

311 R. D. Q. You have identified the wrappers which were upon the package containing the defendant's concentrate sent to me by registered mail from Helena, Montana, on August 11, 1911, but I have not asked you to describe the manner in which you wrapped up this parcel. Please do so.

A. This bottle, containing the sample of concentrate, which I had

placed in it immediately after my visit to the flotation plant at Basin and which had been continuously in my possession up to the time when I sent it by registered mail to Mr. Williams, I first wrapped up in a new sample sack and then wrapped the paper wrappers about the package so made.

312 R. D. Q. Assume that you were testing an ore in the slide machine, such as you have described, and that the phenomena
134 described by you in answer to 111 X Q. appear, to wit, a loose agglomeration of mineral particles in the bottom of the box or vessel after agitation had ceased. What would you do next?

A. I would give further agitation to the ore pulp in such a test, with the expectation that further agitation would bring such a loose agglomeration up as a froth.

313 R. D. Q. Assume that such further agitation did not bring up this loose agglomeration as a froth, what would you do next?

A. I would throw the test away and make another one, using less oil or oily matter, as I would take this phenomenon to be a sign of over-oiling.

Redirect examination closed.

Deposition closed.

EDWARD H. NUTTER.

Adjourned to Tuesday, February 20, 1912, at two o'clock P. M., at the same place.

New York, February 20, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

CHARLES F. CHANDLER, a witness produced in behalf of complainants, having been duly cautioned and sworn, testified as follows:

135 Direct examination.

By Mr. Williams:

1 Q. Please state your name, age, residence and occupation.

A. Charles F. Chandler; seventy-five years of age; chemist by occupation; residence, the City of New York.

2 Q. Please state your education and other qualifications to testify as an expert in the subject matter in controversy, which is a process for the treatment of ores. In answering this question, please briefly summarize your experience as a teacher, the degrees which have been conferred upon you, and your general experience as an expert testifying in suits involving metallurgical matters.

A. I was educated as a chemist at Harvard University, and the Universities of Goettingen and Berlin. I studied especially physics, chemistry, mineralogy and geology. I began to teach these subjects at Union College in 1857, lecturing upon, among other things, the

chemistry of the metals, and teaching qualitative analysis, assaying, mineralogy and geology.

In 1864 I came to New York and was one of the founders of the School of Mines at Columbia University, teaching particularly chemistry, including the chemistry of the metals, for a time geology, and for a considerable length of time assaying. I had the good fortune to be the inventor of the assay weights which are now generally employed in the United States and Great Britain. I have
136 consequently had to do with minerals and ores and the extraction of metals from their ores. I have been frequently called upon for the last forty years either to investigate matters connected with the metals and their extraction and with patent and other litigations involving ores and metals, such as the ores of gold, silver, lead, copper, tin and antimony. I was employed as an expert in the aluminum litigations, in the casting of steel, in the hardening of armor plates, manufactured carborundum, was an expert in the famous Johannesburg suit of Thomas and McArthur relating to the cyanide treatment of gold ores, was an expert in the slime filtration suit of Butters and Moore, and other cases. I have received the degree of Doctor of Philosophy from the University of Goettingen, Doctor of Laws from both Union College and Columbia University, Doctor of Medicine from the University of New York, and Doctor of Science from Oxford.

3 Q. Have you examined the patent in suit No. 835,120, issued November 6, 1906, for improvement in Ore Concentration, and do you understand it?

A. I have examined this patent and I understand it.

4 Q. Please now explain the invention pointed out in all claims of the patent, excepting claims 4, 8 and 13, and the specification and drawing so far as may be necessary to that end.

By Mr. Kremer: Defendant objects for the reason that the
137 witness is called upon to predicate expert testimony upon facts not shown by the record, and the basis of the testimony is too indefinite to permit the same being competent at this time.

It is stipulated that this objection shall be continued without repetition to all questions along this line.

A. This patent is entitled "Ore Concentration" and I cannot indicate the character of the invention better than by quoting:

"This invention relates to improvements in the concentration of ores, the object being to separate metalliferous matter, graphite, and the like from gangue by means of oils, fatty acids, or other substances which have a preferential affinity for metalliferous matter over gangue."

Before beginning to describe the nature of their invention, the patentees refer to the Cattermole granulation process, in which oily matters were employed in ore concentration in a manner totally different from that of the patent in suit. I cannot do better than quote from the specification, as follows:

"In the process described in the previous United States patent,

No. 777,273, granted to A. E. Cattermole, an amount of oil varying from four per cent. to six per cent. of the weight of metal-
138 liferous matter present is agitated with an ore pulp, so as to form granules which can be separated from the gangue. In the previous United States patent, No. 777,274, granted to A. E. Cattermole and others, a similar method of separation is employed, oleic acid being produced in situ in the ore pulp."

Without going into details I would state, that in both these patents so large an amount of oily matter is employed as to agglomerate together the metalliferous matter contained in the ore into granules or pellets of substantial size, but at the same time the amount of oily matter is not sufficient to float the metalliferous matter, but, on the contrary, the pellets, owing to the specific-gravity of the metalliferous matter, are so heavy they remain at the bottom of the vessel containing the pulp, even when an up-current of water is employed, while the non-metalliferous matter or gangue, while being considerably heavier than water, are nevertheless carried up through the liquid and discharged over the upper edge of the vessel, the result being a comparatively complete separation of the metalliferous matter remaining below from the non-metalliferous matter which passes away with the upward current of water.

The patentees then go on to explain the nature of their invention. They make the following statements:

"We have found that if the proportion of oily substance be con-
139 siderably reduced—say to a fraction of one per cent. on the ore—granulation ceases to take place, and after vigorous agitation there is a tendency for a part of the oil-coated metalliferous matter to rise to the surface of the pulp in the form of a froth or scum."

This discovery is the foundation of the invention described and claimed in this patent. The patentees then go on to describe the peculiarities of the process which they have devised, making the following statement:

"This tendency is dependent on a number of factors."

The first item refers to the use of a small quantity of acid and is given in the following words:

"Thus the water in which the oiling is effected is preferably slightly acidified by adding, say, a fraction of one per cent. up to one per cent. of sulphuric acid or other mineral acid or acid salt, the effect of this acidity being to prevent gangue from being coated with oily substance, or, in other words, to render the selective action of the oil more marked; but it is to be understood that the object of using acid in the pulp according to this invention is not to bring about the generation of gas for the purpose of flotation thereby, and the proportion of acid used is insufficient to cause chemical action on the metalliferous minerals present."

140 The second factor referred to as influencing the tendency for the oil-coated metalliferous matter to rise to the surface of the pulp and form a froth or scum is the application of heat to

the pulp, that is, the mixture of ore and water, and is stated in the following quotation:

"Again, we have discovered that the tendency for the oily substance to disseminate through the pulp and the rapidity with which the metalliferous matter becomes coated is increased if the pulp is warm."

In other words, warming quickens the action of the oil. The third factor which the patentees mention refers to the necessity of reducing the ore to a state of fine subdivision so that the oiled particles of metalliferous matter may readily rise to the surface in the form of foam. It is stated in the following words:

"The formation of froth is assisted by the fine pulverization of the ore, and we find that slime mineral most readily generates scum and rises to the surface while larger particles have less tendency to be included in the froth."

The next topic taken up by the patentees in the specification refers to the fact that ores are not all alike and that different ores may require the use of different oily materials in order to secure the desired separation of the metalliferous matter from the gangue by
141 the production of a froth. The following is a statement from the specification:

"The proportion of mineral which floats in the form of froth varies considerably with different ores and with different oily substances, and before utilizing the facts above mentioned in the concentration of any particular ore a simple preliminary test is necessary to determine which oily substance yields the proportion of froth or scum desired."

This is the general statement of the invention. The patentees then follow the statement with an example, selecting an ore containing ferruginous blende, that is, sulphide of zinc containing iron, and galena, which is sulphide of lead, and a gangue consisting of quartz, rhodonite, and garnet. They direct that this ore finely powdered is to be mixed with water containing either a fraction of one per cent. or even one per cent. of a mineral acid or acid salt, mentioning sulphuric acid or waters containing ferric sulphate.

The oily matter which they recommend in this case is oleic acid in very small proportions from 0.02 per cent. to 0.5 per cent. on the weight of the ore; reducing these quantities to pounds of oleic acid per ton of 2,000 pounds of ore, I find that 0.02 per cent. of oleic acid is four-tenths of one pound or less than six and one-half ounces to the ton, while 0.5 per cent. is ten pounds to the ton of ore of oleic acid.

They direct that the mixture be warmed to from 30° to
142 40° Centigrade, which would be 86° to 104° Fahrenheit, and they further direct that the mixture shall be briskly agitated for from two and a half to ten minutes, until the oleic acid has been brought into efficient contact with all the mineral particles in the pulp.

Then they state that

"When agitation is stopped, a large proportion of the mineral present rises to the surface in the form of a froth or scum, which has derived its power of flotation mainly from the inclusion of air bubbles

introduced into the mass by agitation, such bubbles or air films adhering only to the mineral particles which are coated with oleic acid."

They there state—

"The minimum amount of oleic acid which can be used to effect the flotation of the mineral in the form of froth may be under 0.1 per cent. of the ore; but this proportion has been found suitable and economical."

0.1 per cent. of the ore is two pounds of oleic acid to the ton of 2,000 pounds of ore, that being the ton usually employed in the United States.

The patentees state that if the ore is crushed to ninety meshes to the linear inch, which means so that it will all pass through a sieve of that mesh, that the froth may contain as much as 70 or 80 per cent.
of the metalliferous matter present in the ore. All that re-
143 mains after the froth is produced is to remove the same by skimming or otherwise.

No particular apparatus is claimed in this patent for the carrying out of the process, although, in order to make the process clearer to the reader, an apparatus is figured and described, which is suitable for the purpose.

This is the process of the patent.

Turning to the claims I notice that—

Claim 1 calls for—

"1. The herein-described process of concentrating ores which consists in

(a) mixing the powdered ore with water,

(b) adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of one per cent. on the ore),

(c) agitating the mixture until the oil-coated mineral matter forms into a froth, and

(d) separating the froth from the remainder by flotation."

Claim 2 calls for—

"2. The herein-described process of concentrating ores which consists in

(a) mixing the powdered ore with slightly acidified water,

(b) adding a small proportion of an oily liquid having a
144 preferential affinity for metalliferous matter (amounting to a fraction of one per cent. on the ore),

(c) agitating the mixture until the oil-coated mineral matter forms into a froth, and

(d) separating the froth from the remainder by flotation."

Claim 3 calls for—

"3. The herein-described process of concentrating ores which consists in

(a) mixing the powdered ore with slightly acidified water,

(b) adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of one per cent. on the ore),

(c) warming the mixture,

(d) agitating the mixture until the oil-coated mineral matter forms into a froth, and

(c) separating the froth from the remainder by flotation."

Claim 5 calls for—

"5. The herein-described process of concentrating ores which consists in

(a) mixing the powdered ore with water,

(b) adding a small portion of oleic acid amounting to 0.02-0.5 per cent. on the ore,

(c) agitating the mixture until the oleic acid has been
145 brought into efficient contact with the mineral and has formed a froth therewith, and

(d) separating the froth from the remainder by flotation."

Claim 6 calls for—

"6. The herein-described process of concentrating ore which consists in

(a) mixing the powdered ore with water containing a fraction of one per cent. of sulphuric acid,

(b) adding a small proportion of oleic acid amounting to 0.02-0.5 per cent. on the ore,

(c) agitating the mixture until the oleic acid has been brought into efficient contact with the mineral and has formed a froth therewith and

(d) separating the froth from the remainder by flotation."

Claim 7 calls for—

"7. The herein-described process of concentrating ores which consists in

(a) mixing the powdered ore with water containing a fraction of one per cent. of sulfuric acid,

(b) adding a small proportion of oleic acid amounting to 0.02-0.5 per cent. on the ore,

(c) warming the mixture to 30°-40° Centrigrade,

146 *(d)* agitating the mixture unitl the oleic acid has been brought into efficient contact with the mineral and has formed a froth therewith, and

(e) separating the froth from the remainder by flotation."

Claim 9 calls for—

"9. The process of concentrating powdered ores which consists in separating the mineral from the gangue by

(a) coating the mineral with oil in water containing a small quantity of oil,

(b) agitating the mixture to form a froth, and

(c) separating the froth."

Claim 10 calls for—

"10. The process of concentrating powdered ores which consists in separating the mineral from the gangue by

(a) coating the mineral with oil in water containing a small quantity of oil,

(b) warming the mixture,

(c) agitating the mixture to form a froth, and

(d) separating the froth."

Claim 11 calls for—

147 "11. The process of concentrating powdered ore, which consists in separating the mineral from the gangue by

(*a*) coating the mineral with oil in water containing a small quantity of oil, and a quantity of acid insufficient to cause chemical action on the metalliferous minerals present,

(*b*) agitating the mixture to form a froth, and

(*c*) separating the froth."

Claim 12 calls for—

"12. The process of concentrating powdered ore which consists in separating the minerals from gangue by

(*a*) coating the minerals with oil in water containing a fraction of one per cent. of oil on the ore,

(*b*) agitating the mixture to cause the oil-coated mineral to form a froth, and

(*c*) separating the froth from the remainder of the mixture."

In reviewing these claims I notice that in all of them, first, the ore is to be mixed with water.

Second, the mixture is to be agitated.

Third, an oily liquid is to be added.

Further, in three of the claims, 5, 6 and 7, the particular oily liquid, oleic acid, is directed.

And further I notice that in all of these claims, the amount of oily liquid is specified, either as a fraction of one per cent., as in claims 1, 2, 3 and 12, or as a small quantity in claims 9, 10
148 and 11, or to the percentage, in the cases of oleic acid, .02 to .50 per cent. in claims 5, 6 and 7.

Fourth. The addition of acid to the water is mentioned in claims 2, 3, 6, 7 and 11, and sulphuric acid is referred to specifically in claims 6 and 7. The percentage of acid to the water is specified as a fraction of one per cent. in claims 6 and 7. In claim 11 the percentage of acid is not mentioned, but it is stated that the quantity of acid employed must be insufficient to cause chemical action on the metalliferous minerals present.

Fifth. The application of heat or the warming of ·ter or mixture of oil and water is mentioned in claims 3, 7 and 10 and in claim 7 it is said,

"warming the mixture to 30°-40° Centigrade," equivalent to 86°-104° Fahrenheit.

Sixth. In every claim the separation of the froth is mentioned as the end of the process.

Adjourned to Wednesday, February 21, 1912, at two o'clock P. M., at the same place.

New York, February 21, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Direct examination of Dr. Chandler continued:

5 Q. Have you read the deposition of Edward H. Nutter which precedes your present deposition?

149 A. I have.

6 Q. Mr. Nutter testified that he sent to me by registered mail a sample of defendant's concentrate and he identified the inner and outer wrappers of that bottle, which are in evidence as "Complainants' Exhibit, Inner Wrapper of Defendant's Concentrate" and "Complainants' Exhibit, Outer Wrapper of Defendant's Concentrate." Please state what you know as to the identity of these exhibits and as to the subsequent history of that package and bottle.

A. Referring to my note book, I find the following entry in my own handwriting:

"August 18, 1911—Friday.

Office Henry D. Williams, 76 William Street.

Package of ore in small bottle from Mr. E. H. Nutter, Helena, Montana. Opened in Mr. Henry D. Williams' office by C. F. Chandler in presence of Mr. Williams and Mr. Oscar Spitzer. Seals and marks intact. Bottle taken by C. F. C. for analysis."

This bottle has been in my possession ever since. I brought it here this morning and I have wrapped it up in the original papers as it was wrapped when I opened it. I find that I have endorsed on the wrapper the fact that I opened it on the 18th of August. I also find that I made the same endorsement on the inner wrapper, and I now produce the bottle as I received it originally except that it now bears a label with my laboratory number, 4,289. The
150 sample contained in the bottle is not in the same condition that it was in when I received it upon opening the package. At that time it was moist and adhered more or less to the inside of the bottle. The first thing I did with it was to wash it out with pure ether, using several applications, filtering the ether and returning the small portion of the material which came out with the ether to the bottle and allowing the ether which adhered to it to evaporate. Consequently the powder is now dry.

7 Q. What, if anything, have you done in the way of examination of and testing the material which was in this bottle when you received it and which is now, as you state, in a dry condition, and what did you find as the result of your examination and test as to the materials that were present in this bottle?

A. The first thing I did, after extracting with ether, was to evaporate the ethereal solution in a glass vessel, and I found that it left behind an oily residuum which I tested to see if it were a fatty oil or a free fatty acid. I found that it dissolved freely in 80 per cent. alcohol, which, is a characteristic of oleic acid, oils in general not dissolving in alcohol. I found that it was non-volatile at 212° Fahrenheit and that it had no odor characteristics of any essential oil. It had the ordinary oily odor of oleic acid. It was insoluble in water. I put some water upon it and this water showed an acid reaction to litmus paper. I tested the water after it had been in

contact with the oil by adding a drop of hydrochloric acid
151 dilute and some barium chloride and detected the presence of a small quantity of sulphuric acid. In order to make sure that the oil contained no ore, fine particles of ore, I redissolved it in ether and found the solution to be perfectly clear and limpid, showing that the oil was free from mineral matter. I weighed the oleic acid and found that it weighed .0737 gram. I then weighed the dry concentrate and found it to weigh 20.452 grams, and on calculating the percentage of oleic acid I found it to be 0.36 per cent., which is equivalent to 7.2 pounds per ton of 2,000 pounds of the concentrate.

I then began an analysis of the contents of the bottle, which was continued and completed by my associate, Prof. J. Floyd Metzger, who is at the head of the department of Analytical Chemistry in our School of Mines and the other schools of applied science. The results of this analysis are as follows:

	Percentages.
Insoluble residue	3.04
Zinc	55.47
Sulphur of zinc	27.14
Zinc sulphide	82.61
Iron	1.80
Lead	0.59
Copper	0.76
Manganese	2.99

We did not determine the amount of sulphur in the ore. We simply calculated the amount of sulphur necessary to convert
152 the zinc into sulphide. Nor did we determine the earthy matter in the ore. The water associated with the ore in the bottle weighed 8.55 grams. The bottle now contains all of the material except what was employed in making the analysis. I might say further that I examined the powder contained in the bottle critically under the microscope and found that it was a metallic mineral having the appearance of zinc blende, sulphide of zinc.

By Mr. Williams: The bottle produced by the witness and the material therein are offered in evidence and marked "Complainants' Exhibit, Defendant's Concentrate."

By Mr. Kremer: Defendant objects to the offer in evidence of the alleged concentrates for the reason that it is shown from the record that no part of the contents of the bottle here offered is in the same condition as when received and opened by the witness, no part of the original froth or concentrate with its various ingredients having been preserved so as to identify the character of the original contents of the bottle.

8 Q. Did you make any determination as to the physical condition as to size of particles in "Complainants' Exhibit, Defendant's Concentrate?" And, if so, what did you do?

A. I took it up into the laboratory of the School of Mines and sifted it through their standard sieves. I found that 99.91
153 per cent. passed through 150 mesh sieve, while 9/100 of one per cent. failed to do so, about one-third of that .09 of one per cent. lodged on the 60 mesh sieve; about another third, a little more than a third, lodged on the 80 mesh sieve; a little less than one-third of the .09 of one per cent. lodged on the 100 mesh sieve, while a mere trace lodged on the 150 mesh sieve. I united all the portions together again and returned them to the bottle. I would say that, in speaking of the sieve, the number represents the number of holes to the linear inch; sieve 60 means a sieve with 60 holes to the inch, and so on.

9 Q. Did you make any tests of the oil extracted from this concentrate in addition to what you have described?

A. I tested the oil for sulphur, with the assistance of Dr. Metzger, and we found .00033 gram of sulphur; which is one-third of one millegram, a quantity so small as to be negligible.

It is stipulated that a specimen of defendant's ore in partially crushed condition was received by counsel for complainants and that the specimen now produced marked "Complainants' Exhibit, Defendant's Coarse Crushed Ore" is such specimen which has been subjected to a subsequent crushing operation now to be described.

10 Q. I now hand you "Complainants' Exhibit, Defendant's Coarse Crushed Ore," and ask you to state what you did with it after I delivered it to you.

154 A. I opened the bag of this material, examined it, took out a sample as nearly a fair average as possible for analysis, which was made by Dr. Metzger, with the following result:

	Percentages.
Insoluble Material	57.37
Zinc	21.18
Copper	0.48
Oxide of iron	3.55

I subsequently took the rest of the contents of the bag to the School of Mines building and had it ground in our regular mill, making sure at first that the mill was perfectly clean. It was first ground so that it all went through a 40 mesh sieve. The material that had passed through the 40 mesh sieve was then sifted on an 80 mesh sieve and the portion which failed to pass through this sieve was ground again until it did all pass through. This is the material in the bag.

11 Q. Please describe any tests that you have made with the material identified as "Complainants' Exhibit, Defendant's Coarse Crushed Ore."

A. After I had ground this ore, I proceeded to make some practical tests with it in the slide machine which has been described by Mr. Nutter in his testimony. 400 grams of the ore was taken, together with 1,600 grams of water previously warmed, the temperature of

the mixture being 40° Centigrade. To the mixture of ore and water,
100 cubic centimeters of 5 per cent. sulphuric acid were added,
155 containing 5 grams of sulphuric acid. There was then added
.7 of one cubic centimeter of oleic acid from a bottle brought over from London by Mr. Ballantyne, this volume of oleic acid being the equivalent of 0.64 gram. The mixture was agitated at the rate of about 1,200 revolutions a minute, was allowed to stand a few minutes and the froth was taken off, the water taken off with the froth was then replaced with fresh warm water, the mixture was again agitated and the second froth was taken off. This was repeated until six successive froths had been taken off, the last one in very small quantity. After the sixth froth had been taken off, the water was replaced as before and on agitating and standing no more froth made its appearance. 10 more centimeters of 5 per cent. sulphuric acid were then added and the mixture was again agitated, but on standing it gave off no more froth. The tailings were then drawn off and preserved.

The six successive froths that had been taken off the slide machine having been filtered all on the same filter were then returned to the slide machine, warm water was then added until the level reached the same height as before. Ten cubic centimeters of 5 per cent sulphuric acid were added, the mixture was agitated a little, another 10 cubic centimeters of 5 per cent. acid was added and the mixture was agitated again. It was then allowed to stand for a few minutes and
the froth was removed and filtered and constituted the con-
156 centrate. The material which did not rise to the surface as
froth was collected and preserved under the name of middlings. This I call Experiment No. 1.

I then conducted a second experiment, which I call Experiment No. 2. The same quantities of ore, water and oleic acid were employed as in Experiment No. 1. The oil, however, instead of being the oleic acid brought from London, was the regular oleic acid from my supply at Columbia University, made by Charles Cooper & Co. The amount of acid used in Experiment No. 2 was not exactly the same as in Experiment No. 1. 30 cubic centimeters were first added. After the second froth had been removed, 10 cubic centimeters more were added. After the third run, 10 cubic centimeters more were added. On examining the tailings after the fourth froth had been removed, I found that they were not acid in reaction and so we added 10 cubic centimeters more and agitated again, obtaining a little froth. The treatment of the froth was identical with the treatment in Experiment No. 1, except that only 10 cubic centimeters of dilute sulphuric acid were employed.

Experiment No. 3 was conducted in the same manner as Experiments 1 and 2, the quantity of ore, water and oleic acid being the same and the oleic acid being that obtained from the University, manufactured by Charles Cooper & Co. With regard to the amount of sulphuric acid employed, 30 cubic centimeters were used in the
beginning, 10 cubic centimeters were added after the third
157 foam had been removed, and 10 cubic centimeters after the
fifth foam had been removed.

The fourth experiment was conducted precisely in the same manner as the third, with the same materials.

It is stipulated that a specimen of defendant's feed to his flotation plant was received by counsel for complainants on or about February 10, 1912, and that the specimen now produced marked "Complainants' Exhibit, Defendant's Feed to Flotation Plant" is such specimen.

12 Q. Were the experiments which you have just described made before or after the receipt of the specimen "Complainants' Exhibit, Defendant's Feed to Flotation Plant?"

A. They were made before the receipt of that specimen.

It is stipulated that a specimen of defendant's candlemakers' red oil or impure oleic acid was received by complainants' counsel with the specimen last referred to, and that the specimen now produced marked "Complainants' Exhibit, Defendant's Oleic Acid" is such specimen.

13 Q. I now hand you the specimen "Complainants' Exhibit, Defendant's Feed to Flotation Plant" and the specimen "Complainants' Exhibit, Defendant's Oleic Acid." Please state what, if
158 anything, you did to these materials after I had handed them to you, and what tests, if any, you made with them.

A. I received the two samples you refer to from you and I conducted experiments with them in the slide machine to which I have already referred, using, first, 400 grams of ore, 1,600 grams of water, 30 cubic centimeters of 5% sulphuric acid and 0.8 cubic centimeter of the sample of oil which you had given me; the reason for using the 0.8 of the oil was because it was hot. I had to place it in hot water in order to melt the stearic and palmitic acids which had separated in solid form in the bottom of the bottle. By melting them I was able to make the oil uniform by shaking. This separation of solid fatty acids from the liquid oleic acid must have been caused by the very unusually cold weather which prevailed at the time it was on its way to New York. I would say further that the quantity of oil which I measured out hot was substantially identical with the quantity that I had used in my previous experiments measured cold, namely, 0.7 cubic centimeter. The amount of sulphuric acid used in this experiment was 30 C. C. at the beginning and none afterwards, it being the same 5% solution as used in all the other experiments. The subsequent treatment of the froth was carried out precisely as in Experiments 1 to 4, and this experiment is my No. 5.

My sixth experiment was identical with my fifth experiment, except that I used the oleic acid manufactured by Charles Cooper & Co. instead of the oleic acid from defendant.

159 I now produce a table showing the results of the first four experiments in the weights of ore and oleic acid used, the weights of the tailings, middlings and concentrates obtained and the amount and percentage of oleic acid on each, and then the percentage of the oleic acid on each to the whole amount of oleic acid found.

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	Exp. 1.	Exp. 2.	Exp. 3.	Exp. 4.	Average of four experiments.
Ore taken	400g.	400g.	400g.	400g.	
Oleic acid used...	0.64g.	0.64g.	0.64g.	0.64g.	
Tailings	226g.	184g.	200g.	199g.	202.25
Oleic acid on tailings	0.1715g.	0.084g.	0.092g.	0.103g.	0.1126
% oleic acid to tailings	0.075%	0.046%	0.046%	0.052%	0.055%
% oleic acid to whole oleic acid	20.8%	8.9%	10.7%	13.9%	13.6%
Middlings	87g.	127g.	69g.	39g.	80.5
Oleic acid on middlings	0.3885g.	0.350g.	0.281g.	0.101g.	.2801
% oleic acid to middlings	0.45%	0.28%	0.40%	0.26%	0.35%
% oleic acid to whole oleic acid	47.2%	37.1%	32.8%	13.6%	32.7%
Concentrates	77g.	79g.	121g.	152g.	107.25
Oleic acid on concentrates	0.2635g.	0.508g.	0.486g.	0.537g.	.4488
% oleic acid to concs.	0.34%	0.64%	0.40%	0.35%	0.43%
% oleic acid to whole oleic acid	32.0%	53.9%	56.5%	72.4%	53.7%
Middlings and concentrates	164g.	206g.	190g.	191g.	187.75
Oleic acid on them	0.652g.	0.858g.	0.767g.	0.638g.	.728
Oleic acid percentage	0.40%	0.41%	0.40%	0.34%	0.39%
Percentage of oleic acid to whole oleic acid	79.2%	91.0%	89.3%	86.1%	86.40%

161 I now produce a table showing the results of the fifth and sixth experiments in the same manner:

	Exp. 5.	Exp. 6.	Average of all six experiments.
Ore taken	400g.	400g.	
Oleic acid used	0.64g.	0.64g.	
Tailings	220g.	223g.	207.
Oleic acid on tailings	0.079g.	0.067g.	0.0994
% oleic acid to tailings	0.036%	0.030%	0.047%
% oleic acid to whole oleic acid	11.3%	10.9%	12.7%
Middlings	106g.	130g.	93
Oleic acid on middlings	0.3445g.	0.395g.	0.31
% oleic acid to middlings	0.32%	0.30%	0.33%
% oleic acid to whole oleic acid	49.4%	64.1%	40.7%
Concentrates	68g.	42g.	89.8
Oleic acid on concentrates	0.2735g.	0.154g.	0.37
% oleic acid to concentrates	0.40%	0.37%	0.42%
% oleic acid to whole oleic acid	39.2%	25.0%	46.5%
Middlings and Concentrates	174g.	172g.	182.8
Oleic acid on them	0.618g.	0.549g.	0.68
Oleic acid percentage	0.35%	0.32%	0.37%
Percentage of oleic acid to whole oleic	88.7%	89.1%	87.2%

162 The averages of the first four experiments appear in the last column of the table of these experiments and the averages of the entire six experiments appear in the last column of the table of Experiments 5 and 6.

In making these experiments, I noticed that, when I added together the oleic acid extracted from the tailings, the middlings and the concentrate, I found the sum total to exceed somewhat the amount of oleic acid which I had used in my experiment, and I also noticed that, while the oleic acid I employed was liquid, the fatty material which I extracted from the tailings, middlings and concentrates was substantially solid when cold. This suggested the idea to me that there must have been some fatty material in the ore itself. I consequently treated a sample of each of these two ores employed in these experiments with ether and obtained from each a quantity of solid fat. The ore used in the first four experiments yielded .043 gram of fat, which represents in the 400 grams employed in each of my experiments .172 gram. The ore employed in my last two experiments yielded from 100 grams 0.1085, equivalent to .4340 gram in the 400 grams of ore used in the experiment.

Adjourned to February 22, 1912, at two o'clock P. M., at the Bar Association, 42 West 44th Street, New York City.

163 New York, February 22, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination of Dr. Chandler continued:

14 Q. Have you proceeded further in your investigations as to the results of the several experiments referred to by you as Experiments 2, 3, 4, 5 and 6, and, if so, what have you done?

A. Prof. Metzger has determined the percentage of zinc in the ores which I employed in those experiments and also in the tailings, middlings and concentrates. With these data I have prepared tables showing the results of my experiments in the percentages of recovery. The work involves so many zinc determinations that I, for no particular reason, did not ask him to make the determinations on the results of the first experiment. Consequently these tables do not include that. It was necessary to make zinc determinations on the ores and the zinc determinations on each experiment, which is very laborious, and Dr. Metzger has nearly one hundred students making quantitative analyses under his direction and I was very reluctant to put so much work on him at this time. That is the only reason why I did not give you the products of the first experimental test. The tables which I have prepared give the quantity, percentage of zinc, and grains of zinc and the quantity of ore experimented upon. The

164 first three tables represent Experiments 2, 3 and 4 made with defendant's coarse crushed ore after it had been ground.

Experiments 5 and 6 were made with defendant's feed to flotation plant. The tables also exhibit the weights of the tailings, middlings and concentrates and also the percentage of the same. They also exhibit the percentage of zinc in each, the grams of zinc in each and the percentage of zinc contained in the ore which was recovered in each.

The tables are as follows:

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	Weight.	% Wt.	Zinc %.	Zinc gms.	Zinc % recovered.
Exp. 2:					
Ore	400	100	22.36	89.44	
Tailings	184	46	1.48	2.22	2.5
Middlings	127	31.75	34.57	43.91	49.1
Concts.	79	19.75	51.95	41.05	45.9
Concs. & Middlings	206	51.50	41.23	84.96	95
Total	390	97.50		87.18	97.5
Loss	10	2.50		2.26	2.5
Exp. 3:					
Tailings	200	50	0.88	1.76	2
Middlings	69	17.25	33.41	23.06	25.8
Concs.	121	30.25	51.61	62.45	69.8
Concs. & Middlings	190	47.50	45.00	85.51	95.6
Total	390	97.50		87.27	97.6
Loss	10	2.5		2.17	2.4

	Weight.	% Wt.	Zinc %.	Zinc gms.	Zinc % recovered.
Exp. 4:					
Tailings	199	49.75	1.24	2.47	2.7
Middlings	39	9.75	18.81	7.33	8.2
Concs.	152	38	51.73	78.63	87.9
Concs. & Middlings	191	47.75	50.24	85.96	96.1
Total	390	97.50		88.43	98.8
Loss	10	2.50		1.01	1.2
Exp. 5.					
Ore	400	100	22.42	89.68	
Tailings	220	55	1.44	3.17	3.5
Middlings	106	26.5	44.35	47	52.4
Concs.	68	17	56.05	38.12	42.5
Concs. & Middlings	174	43.5	48.89	85.12	94.9
Total	394	98.5		88.29	98.4
Loss	6	1.5		1.39	1.6
Exp. 6:					
Tailings	223	55.75	1.38	3.08	3.4
Middlings	130	32.50	46.45	60.38	67.3
Concs.	42	10.50	57.39	24.10	26.9
Concs. & Middlings	172	43	49.10	48.48	94.2
Total	395	98.75		87.56	97.6
Loss	5	1.25		2.12	2.4

166 15 Q. In these experiments, what percentage of oleic acid to the ore and what amount of oleic acid to the ton of ore did you use?

A. In order to arrive at the suitable quantity of oleic acid to the ore, I took into consideration the amount of oleic acid which I found in the sample of concentrate which I received through Mr. Williams from Mr. Nutter. That amounted to 0.36%. I then assumed that that concentrate represented one-third of the original ore; that would be 133 grams of concentrate from the 400 grams of ore which I proposed to use. To this quantity I added one-third as much more for an assumed loss on the tailings. This gave me 0.64 grams of oleic acid for the 400 grams of ore which I proposed to employ. This amounts to 0.16% of oleic acid on the ore; that is, 16/100 of one per cent., which is well within the quantity specified in the claims of the patent, which quantity is from .02 to .5 per cent., or from 2/100 to ½ of one per cent.

This percentage .16 represents 3.2 pounds of oleic acid per ton of ore, and my experiments have proved that this is a very proper quantity of oleic acid to secure the results described in the specification.

16 Q. Basing your answer upon the experiments which you have conducted with defendant's ore and with defendant's oleic acid and

other oleic acid and upon the description given by Mr. Edward H. Nutter in his testimony of the ore concentration process as
167 carried on by the defendant at Basin, Montana, please state whether or not, in your opinion, the invention pointed out in claims 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12 of the patent in suit was employed by the defendant.

By Mr. Kremer: Defendant objects, for the reason that it is sought to prove infringement by expert testimony, and the conclusion of the witness is asked upon a state of facts not disclosed by the record, and, further, for the reason that it has not been shown that the samples of ore with which the witness's experiments were carried on was the same ore or the same character of ore said to have been used by the defendant in the alleged operations prior to the institution of this action.

A. In my opinion it was. I base this opinion upon the character of the concentrates which Mr. Nutter forwarded to New York, upon his statement of what he saw at the works, and upon my experiments, in which I carried out the process described and claimed in the patent. The results of my experiments satisfy me that the process described and claimed in the patent and in the claims which you mention would produce just such a concentrate as Mr. Nutter forwarded, and that the apparatus and process which he states that he saw at the works of the defendant would carry out that process and were carrying it out at the time he observed it.

168 By Mr. Kremer: Defendant moves to strike from the record the answer of the witness for the reason that the answer is not based upon a state of facts definitely disclosed by the record or embodied in the question to which the answer is given, and, hence, the answer embodying the conclusions of the witness is proof of no issue in the case; and, further, for the reason that the whole answer is a conclusion not admissible as evidence of expert character.

By Mr. Williams: Notice is now given that the charge of infringement will be limited to claims 1, 2, 3, 5, 6, 7, 9, 10, 11 and 12 of the patent in suit.

Adjourned to Friday, February 23, 1912, at two o'clock P. M., at the office of Henry D. Williams, 76 William street, New York City.

New York, February 23, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination of Dr. Chandler:

17 Q. Have you made sieving tests such as were suggested by counsel at the conclusion of your testimony yesterday, and, if so, what have you done?

A. I have made sieving tests with the set of sieves in use at
169 the School of Mines at Columbia University, the same sieves that I have used in all my sieving tests. I inquired of our

Prof. Walker, head of the Department of Metallurgy, and Prof. Hall, head of the Assay Laboratory, whether these sieves have any distinctive name beyond the number stamped upon each, which represents the number of holes to the linear inch. They both assured me that the sieves had no distinctive names, but that they are the sieves regularly supplied for use in metallurgical and assay laboratories by the largest dealers in such supplies in this country, Eimer & Amend of New York. The following table shows the results of my sieving experiments. The figures in the first four columns express the percentage of material which rested on the sieve heading the column. The fifth column of figures shows the percentage which passed through the finest sieve of 150 meshes to the inch. The last column represents the sum of the fractions as they were weighed. It falls a little short of 100% because, in sifting, a little fine powder is lost by currents in the air.

Sieves.

	On 80.	On 100.	On 120.	On 150.	Through 150.	Total.
Exp. No. 2:						
Middlings	0	3.8	29	14.1	52.2	99.1
Concs.	0	2.7	28.4	14.4	53.2	98.7
Exp. No. 5:						
Middlings	0.6	1.1	9.1	9.6	79.5	99.9
Concs.	0.6	1	7.3	10	81	99.9
Feed to Flotation Plant	1.9	1.9	11.7	13.1	71.1	99.7

170 18 Q. Do the results of these sieving tests in any way modify the testimony which you have given?

A. They do not.

Direct examination closed.

Cross-examination.

By Mr. Scott:

19 X Q. I notice that the patent in suit makes mention of graphite as one of the materials for which the process of the patent is designed. Can you state whether the process as you understand it would be applicable to the separation of graphite from earthy matter with which it occurs in nature?

A. I don't know anything about it.

20 X Q. Will you please define the difference between oils and fatty acids?

A. The word oil is applied to a great variety of products, the application being to a considerable extent based upon the consistency of the liquid, and the greatest variety of substances has been sometimes with special qualifications denominated oils. There are, how-

ever, three classes of substances which are properly called oil. First, the fatty oils, which include bodies which have a basis of glycerine, or some corresponding base. To this class belong all those oils which are capable of being converted into soaps by treatment with caustic alkali, and the class includes the fatty acids when they are liquids at ordinary temperature.

The second class includes the so-called essential oils,
171 mostly of vegetable origin, of which the oil of turpentine, oil of eucalyptus are the best examples.

The third class includes the petroleum products, such as kerosene oil, lubricating oils, etc.

As to the difference between oils and fatty acids, the fatty acids are derived from the fatty oils. The fatty oils may be regarded as salts, compounds of an acid with a base. These fatty oils are easily decomposed by distillation with superheated steam, by superheating in contact with water, by first converting the fatty oil into a soap and decomposing that soap with an acid, or by one of two or three other methods. In such treatment, the fatty oil is broken up into its base, which becomes glycerine and the fatty acid.

When ordinary beef fat or lard or mutton fat is subjected to either one of the above mentioned processes, it yields a mixture of glycerine water and fatty acid. This fatty acid is a mixture of the three acids—

Stearic acid,
Palmitic acid, and
Oleic acid.

On cooling this mixture of fatty acids, a large part of the stearic acid and some of the palmitic acid solidify, crystallizing out, while the oleic acid, retaining more or less stearic acid and palmitic acid, according to the temperature, remains liquid. By straining this mixture of solid and liquid fatty acids, the solid stearic acid is obtained in the form of a cake and is used for making candles,
172 while the oleic acid passes through the cloths and is commonly spoken of in commerce as oleic acid or red oil.

21 X Q. The patent in suit makes use of the term "oily substance." Is it your judgment that this term includes other substances than those which fall within the strict definition of oils?

A. I should be inclined to consider the word oily as used in the patent as equivalent to the word greasy in common language. All the fatty oils are greasy, the fatty acids are greasy, of which the oleic acid mentioned in the patent is an example, petroleum products are greasy, and essential oils are greasy. The two words "oily" and "greasy" are substantial equivalents in ordinary language, in my opinion, and it seems to me that it is to this greasy property of the oil that the success of the process described and claimed in the patent is due.

22 X Q. Is it your judgment that it would make any difference in the practice of the process described in the patent in suit whether the oleic acid used were produced in situ, as referred to in line 27, page 1 of the patent, in connection with the process of A. E. Cattermole, or was simply added to the pulp as you did in your experiments?

A. I have no practical experience on this subject, as in all my experiments I employed oleic acid, but, inasmuch as the patentees have given this mode of treatment as an equivalent for the direct use of oleic acid, I have no reason to doubt its efficiency.

23 X Q. Will you please define the expression "metalliferous matter" as used in line 20, page 1, of the patent in suit?

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A. In the science and art of metallurgy, the expression "metalliferous matter" is employed to distinguish the common metals and their ores from the mineral matter associated with them, which is not metallic in character; for example, gold, silver, copper, lead and zinc, and iron, at least under some circumstances, are the common metals with which the metallurgist has to do, and he calls the minerals containing them metalliferous and thus distinguishes them from such substances as quartz, clay, feldspar, carbonate of lime, silicate of manganese, and such minerals, which neither appear metallic nor furnish metal to the metallurgist, although it may be that they contain what a chemist calls metals. A metallurgist would not call common salt metalliferous, although it contains the metal sodium, because it does not look metallic and it does not yield a metal in ordinary metallurgical process.

23 X Q. Referring to the ore described in lines 72 to 74, page 1 of the patent in suit, I presume that the term "metalliferous matter" would be used in connection with the ferruginous blende and galena as distinguished from the other components of the ore mentioned?

A. That is my opinion, also.

24 X Q. And in the case of the feed to flotation plant with which you experimented, I presume that the term "metalliferous matter" would there be used in connection with the zinc sulphide or blende?

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A. It would.

25 X Q. In the patent to A. E. Cattermole, No. 777,273, which is referred to in the patent in suit, is the expression "metalliferous mineral matter" as used therein, and particularly in lines 74 and 75, of page 2, synonymous with the expression metalliferous matter which is used in the patent in suit, in line 20 of page 1?

A. It is.

26 X Q. Do you think that the use of the word "say" in lines 29 and elsewhere in a similar connection in the patent in suit implies some latitude in the quantity of oil or acid to be used, the word referred to being used in line 38, page 1, in connection with the quantity of acid, and line 29, page 1, in connection with the quantity of oil or oily substance?

A. I understand the word "say" as employed in the specification as equivalent to the expression "for example." As I understand it, it is the duty of the inventor in drawing his patent to give clear and explicit directions as to how his patented process can be practised by persons skilled in the art. In almost all chemical processes, the proportions of re-agents may be varied to a certain extent without interfering with the success of the process, and sometimes a little more and sometimes a little less of a re-agent is desirable, according to the

varying nature of the materials operated upon; and in using
175 the expression in connection with proportion of "say" or "for example," the inventor does not necessarily limit himself to the exact proportions which he mentions. He has found those proportions to be satisfactory; in some cases a little more material may be employed than he mentions, or a little less, but his proportions are substantially correct for most cases, but the person practising his invention may vary them slightly if he finds it advisable in order to secure the best results as described in the patent with the material he has to work upon.

27 X Q. Is it your understanding that, in the treatment of any selected material, such as that in evidence as Feed to Flotation Plant, there is some definite point in the quantity of oil used at which a transition takes place between the effects described in the Cattermole patents referred to in the patent in suit and th effect of flotation for which the process of the patent in suit is described as being useful?

A. I am sure I don't know any exact point of demarkation. Cattermole describes a process in which he used five or six per cent. of oil and so manipulates his material as to cause the metalliferous constituent of the ore to form heavy granules which settle to the bottom, while the non-metalliferous material or gangue is floated off the top or carried off by the current. In the patent in suit, by the use of a fraction of one per cent. of oil and brisk agitation in water, the metalliferous constituent of the ore is floated off at the top as a froth, while the non-metalliferous mineral, the gangue, settles
176 to the bottom. Not only is there an absolute and radical difference in the amount of oil employed, but there is also a radical difference in the mode in which the oil is applied to the ore. There is no object in the Cattermole process of agitating his material so as to produce froth and float his metalliferous mineral to the surface. That is just what he does not want to do. On the other hand, in the patent in suit there is no object in so manipulating materials as to cause the metalliferous material to remain at the bottom. That is just what the patentees do not want to do. So that if either the patentees of the patent in suit or Cattermole so varied their processes that either would produce the results described by the other, he would cease to be carrying out his own process.

28 X Q. Are you able to state whether the Cattermole effect as described in the Cattermole patents referred to in the patent in suit under any circumstances takes place simultaneously with the flotation effect set forth as the object of the patent in suit; that is, by simultaneously I mean, at the same time and in a single operation?

A. I have no knowledge of any such result.

29 X Q. In your judgment as an expert, would the simultaneous effects set forth in the last preceding question occur under any conditions as to quality of oleic acid?

A. I don't know, and I have no opinion.

30 X Q. I invite your attention to the passage extending
177 from line 31 to line 35, page 1, of the patent in suit, in which it is stated that part of the oil-coated metalliferous matter

rises to the surface, and ask what becomes of the remainder of the oil-coated metalliferous matter?

A. It remains in the tailings. I have found in all my experiments that I failed to bring to the surface all of the metalliferous mineral; particles of it were left distributed in the gangue, but they were never in the form of granules. They were always as isolated particles, having for some reason failed to be carried to the surface.

31 X Q. Did you ever see any of these bodies which the Cattermole patents refer to as granules?

A. I have. They consist of particles of metalliferous mineral glued together by oil; not containing a sufficient quantity of oil to make them lighter than water, they necessarily remain at the bottom.

32 X Q. How large a proportion of the ore from which these granules were formed was agglomerated into these granules which you saw?

A. Why the greater part of the metalliferous mineral contained in the ore. The gangue was carried away by the up-current, leaving the metalliferous minerals in the form of granules.

33 X Q. In lines 64-69, page 1 of the patent in suit, reference is made to a preliminary test to determine which oily substance yields the proportion of froth or scum desired. In your judgment, just what proportion of froth or scum is it desirable to secure in

178 practising the process of the patent in suit?

A. The object of applying the process of the patent in suit is to separate the valuable metalliferous particles from the worthless gangue particles, and it is desirable to get out the largest possible percentage of the metalliferous particles. The patentees have found evidently from their statement, to which you refer, that working the different ores, one oily substance may be more efficient in accomplishing the desired result with a particular ore than another oily material. If, therefore, one had a new ore to operate upon, he would naturally test that ore with the different oils at his command, using them in varying proportions, until he found which oily material and which proportion gave him the best results, as it would naturally be his desire in each case to secure the best results.

34 X Q. Have you any knowledge of the practical commercial operation of the process described in the Cattermole patents which are referred to in the patent in suit?

A. I have seen the process practised on an experimental scale, and it operated as described in the patents, but I have never seen it operated on a commercial scale.

35 X Q. Can you state what office or function the mineral acid performs in the operations described in the patent in suit?

A. Its presence facilitates the formation of the froth.

179 Exactly how it does this I do not know, but I have noted in my experiments that when I started with 30 cubic centimeters of five per cent. acid, that I could hasten and increase sometimes the formation of froth by adding a little more acid, say 10 cubic centimeters more, and I sometimes tested the liquid with methyl orange to see if it had an acid reaction. If it did not, I added a little more acid.

36 X Q. Do you consider that maintaining an acid condition of the pulp is necessary in the practice of the operations set forth in the patent in suit?

A. I do not know that it is, but I infer from the fact that the use of acid is recommended and that acid produces an acid reaction, that that would be a desirable condition, though I am not certain of it.

37 X Q. Would the presence of carbonates in the material being treated by the procedure described in the patent in suit affect the quantity of mineral acid necessary or desirable?

A. That would depend upon the nature of the carbonates and upon the nature of the mineral acid. Some acids are much more active than others when they are in a very dilute condition, and some carbonates are not affected by dilute acids, particularly by sulphuric acid. We never use sulphuric acid in our analytical processes by itself for dissolving minerals because it is not as active as some other acids.

38 X Q. In describing one of your experiments, Experiment No. 2, referred to in your answer to Q 11, you stated that on
180 examining the tailings after the fourth froth had been removed, you found that they were not acid in reaction and so added 10 cubic centimeters more of acid, I assume. Would this not indicate that the sulphuric acid previously added had reacted on some of the substances contained in the pulp or mixture of water with the matter treated?

A. I think probably it could, but it must be remembered that, in my experiments, every time I drew off the froth, I carried off a quantity of water, necessarily acid water, and replaced it with fresh water, so that I was constantly reducing the amount of acid present in the liquid. That of course, would not account for the entire disappearance of acid reaction, though after drawing off four successive layers of froth, there would necessarily have been a great reduction in the amount of acid present.

Adjourned to Saturday, February 24, 1912, at 10:30 a. m., at the same place.

New York, February 24, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Dr. Chandler continued:

39 X Q. In treating an ore containing eight per cent. of zinc in the form of blende and the remainder of the ore consisting
181 of non-metalliferous gangue, what would be the maximum and the minimum amounts of oil per ton of ore to be used according to the directions appearing in lines 72-79, page 2 of Cattermole patent No. 777,273?

A. 9½ lbs. is the minimum and 14¼ lbs. is the maximum.

40 X Q. Will you please state what percentage of the amount of

ore figured as a whole these quantities of oil named in your last answer represent?

A. Reckoned in percentages, the minimum is 0.48% and the maximum is 0.71%.

41 X Q. In treating a similar ore containing four per cent. of zinc in the form of blende and the remainder of the ore consisting of non-metalliferous gangue, what would be the maximum and minimum amounts of oil per ton of ore to be used according to the directions appearing in lines 72-79, page 2, of the Cattermole patent No. 777,273? In answering this question, please also state what percentages of the ore as a whole the amounts you give constitute.

A. Naturally the amount of oil used with a four per cent. ore would be half the amount for an eight per cent. ore. The amount, therefore, would be a minimum of 0.24%, a maximum of 0.36%, or a minimum of 4¾ lbs. to the ton, and a maximum of 7⅛ lbs. to the ton.

42 X Q. In treating an ore containing eight per cent. of zinc as blende and the remainder consisting of non-metalliferous
182 gangue, what would be the maximum and the minimum amounts of oil per ton of ore to be used according to the instructions appearing in lines 28-30, page 1, of patent No. 835,120, this being the patent in suit? Will you also apply the same question to an ore containing four per cent. of zinc in the form of blende?

A. The patent in suit, as I understand it, does not specify any particular quantity of oil with regard to the percentage of zinc present in the ore. The specification simply gives general indications of possible quantities that might be found useful. In lines 28-30, to which you refer in your question, no specific quantity is mentioned. The inventors simply state, referring to the Cattermole patent which has just been previously discussed, that four to six per cent. of the weight of metalliferous matter present is employed, that they have found that if the proportion of oily substance be considerably reduced, say to a fraction of one per cent. on the ore, granulation ceases to take place. What this fraction of one per cent. is, they do not mention. The only way in which I can interpret this fraction of one per cent. is by referring to other portions of the specification, where this fraction of one per cent. is expressed in figures; for example, at line 81, of page 1, of the specification, is the following statement; speaking of the ore:

183 "To this is added a very small proportion of oleic acid (say from 0.02 per cent. to 0.5 per cent. on the weight of the ore)."

That is, from 1/50 of one per cent. up to one-half of one per cent. The specification does not intimate that these proportions of oil or oleic acid are to be used indiscriminately on the ores. Special directions are given for preliminary tests with different ores and different oils. Consequently it does not follow from the specification that the maximum quantity of oleic acid mentioned would be used on four per cent. or eight per cent. ores. On the contrary, it is especially stated, beginning at line 96 on page 1 of the specification,

"The minimum amount of oleic acid which can be used to effect the flotation of the mineral in the form of froth may be under 0.1% of the ore, but this proportion has been found suitable and economical."

43 X Q. We will refer again to lines 28-30, page 1, of the specification of the patent in suit, and in connection therewith I would like you to state whether 9/10 of one per cent. is not "a fraction of one per cent."?

A. It certainly is, but the paragraph does not indicate that that is the fraction that the inventors refer to. We have to seek further information in the specification to ascertain what particular fraction they are referring to by the expression "a fraction of one
184 per cent."

By Mr. Kremer: Comes now the defendant and moves to strike out all of the answer except the first three words, for the reason that it is not responsive and argumentative.

44 X Q. In treating an ore containing eight per cent. of zinc as blende and the remainder consisting of non-metalliferous gangue, or, for that matter, containing any other amount of zinc as blende, what amount of oil in pounds per ton would result from computing the same as .9 of one per cent. on the ore?

A. .9 of one per cent. on 2000 pounds would be 18 pounds.

45 X Q. Taxing the proportion of oil as .5 of one per cent., please compute the amount of oil to be used upon the ore referred to in the last preceding question.

A. It would be 10 pounds per ton.

46 X Q. You have stated in discussing lines 28-30, page 1, of the patent in suit that it is necessary to seek further information in the specification of that patent to ascertain what particular fraction of one per cent. of oil is referred to. Will you kindly point out in this patent any passage definitely setting forth any particular fraction of one per cent. that is applicable to the treatment of ores generally?

A. I will examine the specification in its entirety and see what I can find. The first reference to any proportion of oily sub-
185 stance is found in the lines which you have referred to on page 1, lines 28-30. That paragraph, however, is not a statement of any particular quantity which the patentees recommend. It is simply a statement of a discovery which the patentees have made. The first definite statement which I find as to quantity of oily matter is given on page 1, line 81, after the patentees have stated the desirability of simple preliminary tests. At line 81, the patentees say:

"To this is added a very small proportion of oleic acid (say, from 0.02 per cent. to 0.5 per cent. on the weight of the ore)."

These extremes represent from .4 of a pound per ton of ore to 10 pounds per ton of ore. The patentees do not state on what particular condition of the ore this variation of quantity depends, whether it depends upon the percentage of zinc in the ore or some other

quality, but they do indicate that the selection of quantity between these extremes must rest with the person familiar with the art who practises the process and it is fair to assume that such person would decide how much oleic acid to use by the results of the simple preliminary tests suggested by the patentees.

The next place in the specification where I find a reference to the proportion of oleic or oily matter is at line 99 on page 1, where I find the following statement:

186 "The minimum amount of oleic acid which can be used to effect the flotation of the mineral in the form of froth may be under 0.1 per cent. of the ore; but this proportion has been found suitable and economical."

0.1 per cent. of the ore is two pounds to the ton.

And further I notice that in all of the claims in suit the amount of oily liquid is specified either as a fraction of one per cent., as in claims 1, 2, 3 and 12, or as a small quantity, in claims 9, 10 and 11, or in a percentage in the case of oleic acid .02 to .50 per cent. in claims 5, 6 and 7.

47 X Q. Please state how you would proceed in conducting a preliminary test as referred to in the passage extending from line 61 to line 69, page 1, of patent 835,120 in suit.

A. In the same way that I conducted my experiments which I have described in my previous testimony. I should take a weighed quantity of finely pulverized ore and a suitable quantity of water to make a fluid to mix it up; I should put them into a suitable vessel provided with an agitator; I should add a weighed quantity of acid and put in a small quantity of oily matter, noting, of course, the exact proportion of each material. In making my first experiment, assuming, of course, that I am a person skilled in the art, I should use about the proportions that I had previously found to give satisfactory results with other similar ores. If my first selection of proportions of water, acid and oil gave satisfactory results,
187 I should know that I had put in enough of each. I might then, for the purpose of economy, reduce the proportions of oil or water until I found the minimum quantity that would give satisfactory results with this particular ore.

If, on the other hand, I did not obtain satisfactory results with the quantities of oily matter and acid which I employed, I should think one or the other of these substances had been used either in deficient or excessive quantities, and I should use my experience or judgment in changing the proportions for one or more further tests.

48 X Q. The teaching of the patent, as I understand you, consists in directions to perform experiments with different amounts of oil and acid until that amount is hit upon which produces a froth, and then adopting that amount, and that the determination of what is intended to be included within this patent is defined by a result as distinguished from any definition of means to secure such result. Is this correct?

A. As I understand it, the object of this invention as described in

the specification and claims is to extract as completely as practicable the valuable metallic minerals from the ore.

This result is to be accomplished in a certain way, which is described and claimed in the patent, that is, by agitating the ore in extremely fine powder in water which is slightly acidulated and to which a minute quantity of oily matter is added, these ad-

188 ditions and the character of the agitation being such as to cause the metalliferous particles to come to the surface as a froth, while the worthless gangue minerals remain at the bottom of the vessel. Now it is self-evident that no two ores are exactly alike, either in the nature of their metallic minerals or in the percentage, and it is equally self-evident that, that being the case, no hard and fast rule can be laid down for all cases as to the quantities of acid or oily matter to be employed. All that the inventors can say in their specification and claims is the statement as to about how much, in general, acid and oil they have found to accomplish the desired results on ores containing metalliferous minerals.

I don't think your question correctly expresses the teaching of the patent. It is not merely necessary to "produce a froth." One might produce a froth and not get out half the valuable material in the ore. Anyone skilled in the art would understand that he must conduct his preliminary tests until he has ascertained the amount of oil and acid which this particular ore requires for its successful working by the process of this patent. This process does not merely consist in adding oil and acid to the water containing the pulverized ore, but it consists in agitating, agitating it briskly, as the specification says, and agitating it so as to produce a froth which shall contain the valuable metallic minerals of the ore.

189 49 X Q. In following out the directions of the patent in suit, do you find anything in that patent to define the amount of oil to be used other than the results secured by using different amounts of oil, such results taking into account not only the production of a froth but the amount of valuable mineral carried by the froth, as you have suggested?

A. I find on page 1 of the patent, beginning at line 96, the following statement, which I have already quoted:

"The minimum amount of oleic acid which can be used to effect the flotation of the mineral in the form of froth may be under 0.1 per cent. of the ore; but this proportion has been found suitable and economical."

This paragraph certainly contains a direction defining the amount of oil which the patentees find to be suitable and economical. In another place they have intimated that the quantity is not necessarily fixed for all ores and that the person skilled in the art practising the process should make preliminary tests or, at least, may make them, with his particular ore, to discover, if possible, a more suitable proportion than 0.1 per cent. or under. I am trying to see what else your question calls for in the way of an answer. You ask me "do you find anything in that patent to define the amount of oil to be used other than the results secured by using different amounts of oil?" I think the last three words in my quotation from

190 the patent cover everything that is possible, where, in speaking of the proportions to be used, he uses the words "suitable and economical." Necessarily the proportion suitable is the proportion that will cause the largest possible percentage of the valuable metallic minerals to rise in the form of froth, while the largest possible percentage of worthless gangue remains at the bottom of the vessel.

And "economical" naturally refers to costs, which would mean the oil or its equivalent and the proportion thereof which accomplished the desired result at the least expense. I don't mean to say that I find in the specification that it is anywhere stated that one must select the oily matter and determine the proportion thereof which will be most efficient and least expensive. Anyone skilled in the art would read them into any patent. The object of every patented process is to accomplish a result for commercial purposes and such considerations are always understood.

50 X Q. Following your argument, then, the proportion of oil suitable is the proportion indicated by the results, is it not?

A. The best proportion, certainly. That, however, might vary in different localities, according to cost of materials.

51 X Q. By the expression "best proportion" I take it that you mean the proportion of oil which will make the process a success?

A. Yes, a commercial success. The oil that might be

191 most successful as to minimum quantity might be too expensive for practical use. So, in considering the economical phase of the question, the cost of the oil necessary to accomplish the result has to be taken into consideration. That is indicated by the use in the specification, at line 101, page 1, of the words "suitable and economical."

52 X Q. In treating the ore mentioned in the passage beginning at line 72, page 1, of the patent in suit, said ore consisting of ferruginous blende, galena and gangue consisting of quartz, rhodonite and garnet, and assuming that oleic acid costs 5½ cts. per pound, "black oil" 17½ cts. per gallon, red oil (Standard Oil Company's lubricant) 23 cts. per gallon, and Standard Oil Company's paraffin oil 22 cts. per gallon, said prices being in effect at the plant, which of these oils would you use and how much of each in carrying out the process of the patent in suit?

A. I should use the one that would give the best results at the least cost. Of course, I can't decide which one it would be sitting here in a lawyer's office. I should have to go into the laboratory and try them in a preliminary test, and, as the patentees say, they have found 0.1 per cent. of the ore to be a suitable quantity in case of oleic acid, I should probably begin with that proportion of each of the oils which you have mentioned. Of course, I should not be able to avoid thinking that the oil which cost the least per gallon would be most inviting for trial, but on making my pre-

192 liminary test I might find that the process could be carried out successfully by using so much less of the most expensive oily material, which is the oleic acid, that that would be the most economical. The choice, therefore, of oily material and the quantity

which I should use would have to be determined by my preliminary tests. You have stated in your question the price of oleic acid per pound and the price of the other materials per gallon. I think 5½ cts. per pound would be about 41 cts. a gallon for the oleic acid.

53 X Q. Assuming that, from your viewpoint, oleic acid proves to be the cheapest and most efficient, what amount of it would you use in treating the ore previously referred to and described in the patent beginning at line 72, page 1, of the patent in suit?

A. I should use the smallest quantity that would accomplish the result sought. I should probably begin with 0.1 of one per cent., because the inventors have stated that they have found that quantity to be suitable and economical, but, as they say the quantity required may be under that amount, I should naturally reduce the quantity until, for my particular ore, I found the minimum quantity that would accomplish the result of the process of the patent, suitably and economically. I have not mentioned all the consideration that would come in. It is not necessary for the success of the process that every particle of metallic mineral should be taken out of the ore. It often increases the expense of a process enormously
193 to extract the last percentage of valuable material which it contains, and it is, therefore, often very much cheaper to arrange a process of extraction so that one, or even several, per cent. of valuable metallic mineral may be left behind in the gangue. That is one of the considerations that is covered by the expression "economical."

54 X Q. Will you please state where it is that the large proportion of the mineral present rises to the surface in the form of a froth or scum as referred to in lines 89-91, page 1, of the patent in suit; by inquiring where I mean in what part of the apparatus shown in the drawings of the patent in suit?

A. As I read the specification and the description of the apparatus, it seems to me clear, as the specification states, that, when agitation is stopped, a large proportion of the mineral in question rises to the surface in the form of a froth or scum. The agitation takes place in the vessel A in Figure 1. It is further stated that about 70 to 80 per cent. of the metalliferous matter would be contained in the froth and that this froth is removed from the pulp, or may be removed, in several ways, by the use of a spitzkasten, by an up-current, by skimming, draining or otherwise. Then on referring to the apparatus shown in Figure 1, which illustrates the use of spitzkasten for this purpose, it appears that the contents of the agitating vessel A are discharged into a succession of spitzkasten over a smooth, slightly inclined plane. When this apparatus is employed in the
194 manner described, the froth will appear on the top of the liquid in the spitzkasten.

55 X Q. Is it your judgment, as an expert, that the froth would form at the surface of the pulp in the vessel A when agitation is stopped?

A. That depends upon how long an interval is permitted before the contents of the agitated vessel are discharged into the spitzkasten. If one waits long enough, I presume all the froth would rise to the

top in the vessel A, but if the vessel A is discharged as soon as the agitation stops, there will not be time enough for all the froth to rise to the top in the vessel A and the separation would be completed either on the inclined plane or after the mixture reaches the successive spitzkasten.

56 X Q. What is the purpose, as you understand it, in using the trough or apron O, into which the goose neck H discharged?

A. It seems to me that it would give an opportunity for a rising of the froth on the surface and, further than that, it seems to me that the agitation of the gangue particles as they pass over this apron would tend to separate the particles of froth which were entangled with it and thus make the separation of froth more complete; and, further, I think that apron, covered, as it would be, with a sheet of liquid, would tend to prevent the froth from being carried by the current down into the spitzkasten—would tend to keep the froth which had already separated from being mixed up again with the gangue.

195 57 X Q. What, in your judgment, is the purpose of the up-current in the spitzkasten?

A. The patentees have stated what this up-current accomplishes on the second page, beginning at line 87:

"The up-current of water from the taps M, M^1, M^2 prevents the deposition of any slime in these boxes (referring to the first and second boxes). The fine sands or gangue slime settle in the last box J^3, from which they are discharged to waste or further treatment."

58 X Q. Would the up-current, in your judgment, assist in keeping the valuable parts of the ore at the surface in the spitzkasten?

A. I don't know why it should. The froth or scum is already on the surface. If any particles of froth have failed to reach the surface, I suppose the upcurrent might help them a little.

59 X Q. Then it is your idea that, in the operation of the apparatus shown in Figure 1, the valuable particles are spread upon the surface initially and are not raised to the surface from the mass of liquid in the spitzkasten?

A. I have never seen this apparatus in operation on a large scale with a suitable equipment. I have seen it practised on a small scale with a single, little spitzkasten, and there seemed to be no

196 difficulty in the froth separating completely on passing the material from the agitating vessel over the apron to a single, small spitzkasten. The sides of the spitzkasten were opaque, and I could only draw a conclusion of the appearance of the surface of the water in the spitzkasten. It is impossible for me to say how many, if any, particles of froth were carried down into the spitzkasten and subsequently rose to the surface.

60 X Q. And you find nothing in the patent in suit, do you, to explain just what the operation is in the apparatus illustrated in Figure 1 in the patent in suit?

A. Why, yes, I think I find a sufficiently clear explanation. The boxes of the spitzkasten series are all filled with water at the outset. Then when the contents of the agitator A are discharged, they run over the inclined plane or apron on to the top of the water contained

in the spitzkasten. The foam or froth naturally remains on the top, while the gangue settles to the bottom of the successive spitzkasten. Naturally the coarser separate in the first spitzkasten; the medium particles separate in the middle or second spitzkasten; and the fine slime of the gangue settles in the last spitzkasten. This separation is facilitated, first, by the successive increasing sizes of the spitzkasten, which diminishes the rapidity of flow, and, secondly, by the upcurrent in the first and second spitzkasten.

61 X Q. In connection with the theory of operation which you have just explained, what is the meaning of the expression
197 occurring in lines 89 and 90, page 1, of the patent in suit, that a large proportion of the mineral present rises to the surface in the form of a froth or scum?

A. That is a general statement, not referring to any particular form of apparatus, and, of course, that is what happens if the agitation is stopped and nothing further is done. That is what happened in all my experiments, because we took the scum off the top, but in using this particular apparatus which illustrates one method of handling the product of the treatment with oil and agitation, the whole contents of the agitator are transferred to the series of spitzkasten.

62 X Q. Do you find in the patent in suit any example of the practise of the process which is purported to be described couched in such exact terms as to enable anyone to conduct the operation, such exact terms including a description of the ore operated upon and of the amounts of oily matter and acid to be used? I refer to such an example of the process as will instruct one precisely as to how to carry the process out without experimentation or independent investigation.

A. From the very nature of the case, it would be impossible to give exact figures or to limit the process to exact figures as to oil, acid, etc., because no two ores are alike in their composition and consequently no two ores would behave exactly alike, and the proportion of materials must be varied with the variations in composition of the ore; even the ore from the same mines would not be uniform and any one person operating a process at a mine would be obliged, in
198 order to obtain economical results, to vary the proportion of materials. The patentees, it seems to me, have been as explicit as the nature of the case permits in mentioning proportions. They have even selected, in their example, an actual ore, which I am informed is successfully treated by their process at Broken Hill, New South Wales, and they have stated the proportions of acid and oleic acid which they found by experience to be suitable for this ore. I think these statements answer your question in the affirmative.

By Mr. Kremer: Defendant moves to strike out that portion of the answer of the witness based upon alleged information, which the witness states that he has received, for the reason that the same constitutes hearsay testimony and, further, is incompetent.

63 X Q. Why is it that the proportion of the materials used must be varied, even in treating the ore from the same mine?

A. Because the ore varies. The ore from one part of the mine

might contain constituents that are not present in the ore from another part of the mine. The ore from one part of the mine may contain three or four times, or even more, as much metalliferous mineral as the ore from another part of the mine.

64 X Q. Is it your judgment that the presence of a larger amount of sulphides would necessitate the use of a larger amount of
199 oily matter in treating an ore by the process which the patent in suit purports to describe?

A. I have no exact knowledge on this point. It seems quite possible that the more metalliferous mineral there is in the ore, the more oil would be required to bring it to the surface.

65 X Q. Is it your judgment as an expert that more oil would be required for the reason stated in your last preceding answer?

A. I don't know with certainty.

66 X Q. Have you any opinion upon this subject?

A. No, I have no right to have an opinion, because I don't know. I could only guess, and I never think it is proper in giving testimony to guess.

67 X Q. Has your experience in the treatment of ores with oil and acid in connection with processes such as the patent in suit purports to describe been of so limited a character that you are unable to form any opinion as to any possible relation between the amount of oil necessary in the process and the amount of metalliferous sulphides present in the ores?

A. I have already stated in putting my experiments into the record that I always used the same quantity of oil, and, consequently, I have no experience as to what would have happened if I had used different quantities of oil. I have stated the composition of the two ores which I experimented upon. The first ore contained 22.36 per cent. of zinc, and the other ore contained 22.42. The
200 quantity of oil which I employed proved satisfactory for these ores. Whether I should have had to use more or less oil with a richer or poorer ore, I can't say. Possibly I might have used more or less oil in these experiments wtihout interfering with the satisfactory character of the result.

68 X Q. In reply to a previous question as to whether you found in the patent in suit any example of the practise of the process which stated precisely the composition of the ore and the proportions of oil and acid used, you replied that variations in different ores, etc., were such that the patentees could not have been more explicit. Do variations in different ores in any way interfere with the possibility of the patentees having set forth some one specific example of the treatment of a single ore?

A. I should say they had given a specific example of some particular ore. They state that the ore which they had selected as an example contained ferruginous blende and galena as the metalliferous minerals and that it contained quartz, rhodonite and garnet as the gangue constituents. Of course, they couldn't give percentages for they are never constant in the same mine, and the metallurgist practising such a process never knows the exact proportion of these gangue minerals in his ore from day to day on account of their

fluctuations. I should say, therefore, that variations in the ores do interfere with the possibility of prescribing exact proportions of oil and acid for the treatment and that as great precision as is
201 possible from the nature of the case is to be found stated in the example given.

69 X Q. It is to be presumed, is it not, that the ore referred to in line 73, page 1, of the patent in suit, had some definite composition and that the patentees could have given it had they desired?

A. No, it is not. No two pieces of ore taken out of the same vein have the same composition if they are composed of metalliferous minerals and gangue minerals, and consequently the patentees could not know the exact composition of the ore of the mine to which this example applied. Of course, after a given quantity of the ore has been finely crushed and thoroughly mixed, an analysis can be made which will show the exact proportion of the different chemical elements which are present, but it would be very difficult, even in this case, if not impossible, to calculate from such an analysis the exact proportion of each mineral present.

70 X Q. Is the description of the ore contained in lines 72-74, page 1, of the patent in suit, devoid, as it is, of any reference to the relative proportions of the valuable part and gangue, such a description as experts in the metallurgic art use in conveying their ideas to one another about the composition of ores?

A. I should say it was just such a description.

71 X Q. If the ore referred to were being discussed by metallurgists with relation to its treatment by any given separation
202 or classification process, would this description be sufficient, without any reference to the proportions of the different ingredients of the ore?

A. The nature of the description of an ore depends upon the object of the description. If one is going to buy or sell an ore, then, of course, it is very desirable that he should know its value in dollars and cents and he would have to know the kind and percentage of valuable material in it. He might also have to know the composition of the particular minerals which contained the values in order to determine what kind of a process he would have to pursue in order to extract it. But in giving the example in this patent of the application of the process described and claimed for recovering the values, I think the patentees have done all that is necessary. They have stated the names of the minerals, blende and galena, which contain the values, and in stating these minerals by name they have disclosed the nature of the combination. They have also stated the names of gangue constituents, or minerals, from which their chemical composition can be readily deduced, as it is given in all books on mineralogy. For the purposes of this example, it is absolutely immaterial what the proportions are of the different component minerals of the gangue. There is no reason to suppose that it would make a particle of difference in the process of treatment how much was quartz, how much rhodonite and how much garnet.

72 X Q. Is it your opinion that it is also immaterial in
203 the adjustment of the proportions of oil and acid whether the ore referred to contains one proportion or another of ferruginous blende?

A. I have practically answered this question in replying to X Q. 64, 65, 66 and 67, the sum and substance of my statement in these answers being that I did not know.

73 X Q. You have spoken of economic treatment of ores and of commercial results. Keeping in mind the character of ore described in lines 72-74, page 1, of the patent in suit, would you say as an expert that, if this ferruginous blende contained as much iron as zinc, by the use of the quantities of oil which you consider as coming within the terms of the patent, commercial results could be produced?

A. I don't know.

74 X Q. Will you state some means whereby a pre-determined percentage of oily matter could be added to a constantly flowing pulp, that is, a pulp moving in a constant current through a series of vessels?

A. It is easy to determine the rate of flow of pulp and it is easy to regulate the rate of flow of oil by simple mechanical devices. If the oil is contained in a suitable receptacle and has leading from it a discharge pipe provided with an adjustable cock, this cock will be so adjusted as to deliver any desired quantity of oil within a given time to match the flow of the pulp. This is done in the case of purifying water by means of alum. An alum solution of fixed strength
204 is fed into the current of water. It accomplishes its coagulation while the water containing it is on its way to the filter.

75 X Q. Assuming that the constantly flowing pulp contains quantities of ore which vary from time to time, ore which necessarily varies in composition as you state, and assuming that it is necessary to maintain some relation between the quantity of oil and the quantity of ore, such relation varying with the composition of the ore, can you describe any means whereby oily matter could be added to the constantly flowing stream of pulp in the amounts necessary to fulfill the conditions stated?

A. The patentees have stated in their specification that, in working that ore which they described, they found one-tenth of one per cent. of the weight of the ore to be suitable and economical. Now, assuming that this ore varies from time to time in composition, that quantity was evidently sufficient with this ore, notwithstanding the variations. When the ore had one composition, it may have been more than was necessary. It would be pretty difficult and hardly pay for the trouble to vary the quantity of oil for such moderate variations in the composition of the ore as would be likely to occur within short intervals with a finely pulverized ore which had been through the stamps or crushers and the mills, and any intelligent person skilled in the art, in charge of the operations at a mine, could hardly fail to make preliminary tests from time to time on his ore, as suggested in the patent, to see what, if any, variations he should make in
205 the proportion of oil employed.

76 X Q. I think you have failed to answer the preceding

question, which inquires whether you can describe any means whereby oily matter could be added to the constantly flowing stream of pulp in the amounts necessary to fulfill the conditions stated, said conditions being the maintaining of some specified relation between the quantity of oil and ore, said relation varying with the composition of the ore, and the quantity of ore carried by the water also varying from time to time.

A. If I were running such a plant, I should test the tailings from time to time and, if I found they contained more than a minimum amount of valuable metallic mineral, I should increase the quantity of oil or the quantity of acid or both, by opening the stop cock a little wider in the supply pipe so as to discharge a little more oil and a little more acid in a given time. That would be the easiest way to adjust proportions, or I might discharge continuously the maximum quantity of oil and acid which I had found necessary to accomplish satisfactory results and, when less than the average was required, permit the excess to go to waste. I might mention another thing that occurs to me. The water may be used over and over again in the system and, by maintaining a proper degree of acidity in this water, satisfactory results could be obtained.

206 77 X Q. After adjusting the oil supply from time to time as you have stated you would do, you would not know, would you, whether the amount of oil you were using came within the proportions suggested in the patent in suit or not?

A. I don't think it is necessary that you should know whether they come within the proportions mentioned in the patent. Some of the claims do not specify the quantity of oil. The specifications having stated exactly what is to be accomplished and how it is to be accomplished does not limit the exact quantity of oil to be used. It gives hints in several places as to quantities which have been found suitable, has explained that it is a small quantity and given figures to show how small, but has nowhere undertaken to fix definitely the exact quantity of oil to be employed.

The person in charge of the plant, if he understood his business, could judge by the appearance of the froth and the tailings whether the process was going on satisfactorily. If he found it had been going on satisfactorily, he would know that he was using enough of the oil and acid for the purpose. If he feared that he might be using too much, he could cut down the supply little by little until he discovered by examining the froth and the tailings that the process was not working satisfactorily.

Adjourned to Tuesday, February 27, 1912, at 10.30 A. M., at the same place.

207 New York, February 27, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Dr. Chandler continued:

78 X Q. Will you explain the distinction as to the quantity of oil or oily liquid used between those of the claims of the patent in suit

which specify a fraction of one per cent. as the amount of oil or oily liquid, those which specify a small quantity, and those which specify .02 to .5 per cent. on the ore as the quantity of oily matter or oil?

A. The object in employing oily matter in the process of the patent in suit is clearly set forth in the specification. It is further clearly stated that, while a great variety of oils and oily substances may be employed successfully, there is a choice among these oily materials which depends upon the character of the ore, and the inventors direct that a simple preliminary test should be made to determine which oily substance is suitable to carry out the process with any particular ore. When the patentees specify, either in the specification or claims 1, 2, 3 and 12 a fraction of one per cent. of oily matter, they speak of it in the first three of those claims as oily liquid, and in the twelfth claim as oil, thus providing for a sufficient quantity of any oily substance suitable for carrying out the process of the patent.

208 In claims 9, 10 and 11 no maximum figure is given for the amount of oil to be employed. The expression is simply "a small quantity of oil," which, as I understand the language of patent literature, would mean a quantity small enough to accomplish the result described and claimed in the patent, the specification of which clearly indicates that, although the quantity may be variable, it is somewhere about one per cent. or under.

The patentees have selected as the oil to be used in their example oleic acid, and claims 5, 6 and 7 mention this particular oily substance and also mention a proportion which may vary from 0.02 to 0.50 per cent., having evidently found that this is a sufficient margin of variation in quantity and, referring to the specification, I note that they state, in speaking of the particular ore which they select for their example, line 96, page 1,

"The minimum amount of oleic acid which can be used to effect the flotation of the minerals in the form of froth may be under 0.1 per cent. of the ore; but this proportion has been found suitable and economical."

79 X Q. I invite your attention to claims 1 and 9 of the patent in suit and ask you whether the expression "a fraction of one per cent. on the ore," appearing in claim 1, has the same significance as the expression "a small quantity," appearing in claim 9?

209 By Mr. Williams: The question is objected to as calling for an opinion by the witness on a question involving the construction of the claims, which is exclusively for the court, and therefore as calling for incompetent and improper testimony.

A. As a layman and with great diffidence I answer your question by saying that, as I understand the difference in those two expressions, claim 1 limits the amount of oil to a fraction of one per cent. on the ore substantially, while claim 9 limits the quantity of oil not to any particular percentage but to such a small quantity as will produce the desired froth, which is necessarily variable with different oils and different ores and may in some cases exceed one per cent.

80 X Q. Would your understanding as an expert in this art, be the same as that set forth in your last preceding answer?

By Mr. Williams: Same objection.

A. It is.

81 X Q. Will you explain how you proceeded in removing the sample contained in the bottle which you received from Mr. Nutter through Mr. Williams, that is, somewhat more in detail than you have previously done?

A. The first thing I did was to weigh it, bottle, cork and wet ore.
The second thing I did was to take out the cork and rinse out
210 the bottle several times with ether, filtering the ethereal solution into a glass dish and allowing the ether to evaporate on a hot plate heated by electricity. When the ether had all evaporated and nothing remained but the oleic acid, I weighed the glass dish containing the oleic acid and then subtracted from this weight the weight of the empty dish which had been noted before I began the experiment. This gave me the weight of the oleic acid contained in the sample.

I then carefully brushed that portion of the mineral which came upon the filter with the ether back into the bottle, returned the cork and weighed the bottle, cork and dry ore, minus the oleic acid. I found that the bottle of ore had lost 8.630 grams. Deducting the oleic acid 0.0737, I found the difference to be 8.5563. That represents the water that was either mixed with the mineral or contained in the cork.

I then poured the dry ore or mineral out of the bottle and weighed the dry bottle and dry cork and subtracted it from the weight of dry bottle, dry cork and dry mineral; the difference was 20.452 grams, which represents the weight of the dry mineral.

82 X Q. Is it your judgment as an expert in the science of chemistry that your determination of the amount of oleic acid upon the concentrate contained in the bottle necessarily represents the amount of oleic acid upon the concentrate as it existed in the vessel from which Mr. Nutter says he took it, that is, is it your judgment that
there would possibly have been some loss of oleic acid by
211 reason of the same either dropping from Mr. Nutter's hand or from its having adhered to his hand and remained upon his hand when he transferred the sample from his hand to the bottle?

A. In my judgment it does. In my opinion it would not be possible for a mixture, in which the quantity of oleic acid was necessarily so small and which was evidently very wet with water, to have lost any of its oleic acid in the few moments contact with Mr. Nutter's hand while he transferred it to the bottle. The amount of water was 117 times the amount of oleic acid and the film of oleic acid upon the ore or mineral must have been infinitely thin. I can't conceive of any of this film of oil passing from the mineral to Mr. Nutter's hand. As he skimmed it off the surface of the vessel, it must have been dripping with water.

83 X Q. As this concentrate came to you for examination in the laboratory, you would never have contemplated the idea, would you, of handling it with your hands; that is, you would not have considered such a procedure as conducive of accuracy, would you?

A. No, because I had to determine the amount of water in it. If the water had been already removed, I do not believe it would have made any difference whether I handled it in my hands or not, as I do not think any of the oleic acid would have rubbed off the dry mineral.

84 X Q. Will you explain the distinction between the significance of the expression "warming the mixture," occurring in claim
212 10, and the expression "warming the mixture to 30°-40° centigrade," occurring in claim 7?

By Mr. Williams: The objection to 79 X Q. is repeated.

A. I notice, on comparing these two claims, that claim 10 is a claim in which "a small quantity of oil" is directed with no reference to any special oil, and the exact degree of warming is not specified. The claim is general, for any oil, and the warming could be varied to suit the oil and the ore. Claim 7, however, is an oleic acid claim and here a specific temperature is mentioned, namely 30°-40° centigrade, which is equivalent to 86°-104° Fahrenheit, the patentees having probably found that this is a suitable temperature with oleic acid; so this is a more specific claim.

85 X Q. What is your judgment as an expert regarding the possibility of carrying out the process which the patent in suit purports to describe, using oleic acid in its solid form?

A. I never saw any solid oleic acid. While the melting point of solid oleic acid is stated to be 14° centigrade, which is 57° Fahrenheit, that is not its solidifying point. It solidifies at 4° centigrade, which is 39° Fahrenheit. The consequence is that, under ordinary circumstances, we never see it in its solid form. If it should be solid on any occasion where it was desired to use it, it would be
213 very easy to melt it, either before it is added to the water containing the ore, or afterward when the water is warmed, as directed in the specification.

If, in your question, you intended by "oleic acid" a cheap commercial oleic acid containing more or less palmitic or stearic acid, or both, that might, of course, solidify at a temperature above the solidifying point of pure oleic acid, that is, above 39° Fahrenheit, but in this case such solidified impure oleic acid could be melted either before or after it is added to the mixture of water and ore.

86 X Q. Would it, in your opinion as an expert, be necessary to melt the commercial oleic acid either prior to its addition to the pulp or while in the pulp in order to carry out the process which the patent in suit purports to describe?

A. I certainly think it would be desirable and I think very possibly it would be absolutely necessary for the proper conduct of the process described in the patent in suit that the oily body should be in a liquid form, and if any one undertook to use a solid oily substance, I think it would be perhaps absolutely necessary that the same should be melted either before or after it is mixed with the ore and water, so that, when the mixture is agitated, it will become so finely divided that it may attach itself to the metalliferous mineral and cause the same to produce a froth. I can't see how it would be possible for a piece of solid fat, like pure stearic acid, for

214 instance, to float about in a tank of water and succeed in producing a film on the minute particles of metalliferous mineral, and in my opinion nobody skilled in the art would be likely to select a high melting solid fat to carry out the process of the patent, although he might possibly be able to do it if he tried hard. Of course, I do not mean to say that a piece of solid fact, like stearic acid, a candle end, for example, might not contribute its part to the production of a froth if it has first been ground up with the ore, and thus thoroughly diffused mechanically among the particles. When an ore carrying a small quantity of stearic acid introduced in this way is put through the process of the patent in suit along with a suitable quantity of oleic acid, the heat of the warm water would undoubtedly cause the oleic acid to assimilate the stearic acid. The mixture would then correspond to a cheap commercial oleic acid, and would accomplish the result described and claimed in the patent. As a matter of fact, I found, as I have already described, a small quantity of a solid fat, presumably stearic acid from candle ends, in the two different samples of defendant's ore upon which I made my six experiments.

87 X Q. In your opinion, which process would require more violent or more prolonged agitation, that set forth in the patent in suit or that set forth in the Cattermole patents which are referred to in the patent in suit?

A. I should be decidedly of the opinion that the process of the patent in suit would require the most violent agitation, be-
215 cause in that process it is necessary to entrain air into the mixture of ore and water in order to produce a froth, whereas in the Cattermole process no froth is to be produced, the metalliferous minerals are not to be carried to the top of the liquid; on the contrary, it is the gangue minerals which are to be carried to the top and this is accomplished by an up-current of water and not by the introduction of air. I should think that the agitation in the Cattermole process would be likely to be more prolonged. I have found that the time of agitation in the process of the patent is extremely limited. I think the first agitation was not more than one or two minutes in my experiments, and the later agitations, after the first froth had been removed, not more than a quarter of a minute. I have no knowledge of the length of time to which the process of agitation is prolonged when working on a large scale.

88 X Q. Will you describe a little more particularly than you have done the form and other characteristics as you noted them of the granules which appeared in the demonstration of the Cattermole process which you saw?

A. I have already described these granules in my answer to X Q 31. I can only add that they appeared as little pellets or pills. By gently agitating them in a bottle of water, I found that they gradually coalesced and became larger, the number being reduced while the size increased. Taking one of them out of the
216 bottle, I found they were soft, would yield to the pressure between the fingers, and when cut in two with a penknife were found to be solid, not hollow.

89 X Q. Do you remember what kind of oil was used in the demonstration of the Cattermole process?

A. The oil used in that case was a mixture of Texas petroleum, oil of turpentine, soap and water. It was an emulsion. 25 cubic centimeters of this emulsion were added to 400 grams of Broken Hill tailings, 1,200 cubic centimeters of water, and ¼ per cent. of sulphuric acid on the water. This mixture was put into a cone mixer and agitated.

90 X Q. Then the difference betweeen the demonstration of the Cattermole process which you witnessed and your own experiments as previously described by you was not simply a difference in the amount of oleic acid used, but the demonstrations of the two processes differed in many other particulars, including the nature of the oily matter itself and the emulsification of the oily matter in the Cattermole experiment with soap?

A. Of course, I could not conduct the Cattermole process in the same way I conducted my experiments with oleic acid. My object was entirely different in the two cases. My object in my experiments with oleic acid and the two samples of the defendant's ore was to find out whether, when the process was conducted according to the patent in suit with oleic acid, it would yield such a product as had been secured by Mr. Nutter and handed to me for
217 examination. My only object in conducting the Cattermole process was to see what the granules looked like and how the process worked. It really was simply to gratify my curiosity.

It is, of course, quite true that the processes in my experiments differed in the manner you suggest in your question. There was no reason why they shouldn't. I had no object in comparing this Cattermole process with the process of the patent in suit with the use of oleic acid; in fact, I didn't suppose I should ever be examined on the Cattermole process. I was not engaged in studying the prior art.

91 X Q. Who performed the demonstration of the Cattermole process which you witnessed?

A. I was assisted in this experiment by Mr. A. Howard Higgins.

92 X Q. Who is Mr. A. Howard Higgins?

A. He is a very agreeable young man who recently came to New York and I had the pleasure of making his acquaintance. I understand he has some connection with the Company known as Minerals Separation, Limited, one of the complainants.

93 X Q. Is it your opinion that the Cattermole process referred to in the patent in suit can be successfully carried out with oleic acid in place of the oily matter used in the demonstration which you witnessed?

A. I have no reason to doubt it. Cattermole makes the following statement:

218 "The oil used may be animal, vegetable or mineral oil or mixtures of these or such coal or wood tar products or other substances which exercise, like oils, a preferential physical affinity for metallic mineral matter as distinguished from gangue."

Oleic acid is such a kind of oil. Therefore, I have no reason to suppose that oleic acid would fail to accomplish the result described and claimed in the Cattermole patent. Of course, I do not fail to note that Cattermole prefers to use an emulsifying agent, which he says has a decided effect in aiding the granulation, and he mentions oleic soap, which, in the presence of the acid which he also employs, would liberate oleic acid.

94 X Q. Have you any information or opinion as an expert upon the subject of the preceding question aside from what you have referred to as being in the Cattermole patent?

A. I have not.

95 X Q. You have referred to certain preliminary tests recommended in the specification of the patent in suit. Now, assuming that one skilled in the metallurgic art is informed of the fact that, when, under proper conditions, sulphide ores are pulverized and mixed with water, oil and acid, and then agitated, a froth carrying a sulphide is formed, I understand it to be your opinion that a simple preliminary test is all that is necessary to determine the proper
219 proportions of oily matter and acid to produce a froth containing the maximum amount of the sulphides; that is, the maximum amount within the commercial requirements. Is this correct?

A. It is. Of course, a person skilled in the art, in attempting to practise the process of the patent in suit, would have the benefit of all the information which is given in the specification of the patent; therefore, he would not be obliged to make random experiments. He would probably start on a new ore by following the directions of the example. If the results are not satisfactory, he might modify the proportions according to his best knowledge and see if he could improve the results, by varying the proportions of oil or acid or by selecting a different oil from the one with which he first experimented.

97 X Q. Do you know whether, in actual practise of flotation processes of the general type of that which the patent in suit purports to describe, the pulp after agitation is permitted to flow through an open trough similar to trough O shown in Figure 1 of the drawings of that patent?

A. I do not.

98 X Q. In operating an apparatus like that illustrated in Figure 1 of the drawing of the patent in suit, would it be necessary to stop the agitator at intervals in order to accomplish the object of the process?

A. I do not know.

99 X Q. Do you find anything in the patent in suit to
220 explain whether it would be necessary to stop the agitator at intervals?

A. The patentees, at line 89, page 1, tell what happens if one does stop the agitation, but, as I understand the drawing, the process seems to be a continuous one.

100 X Q. You have stated that after adjusting the rate of supply of oil to the pulp in order to accomplish satisfactory results in carrying out the process which the patent in suit purports to describe, you

don't think it is necessary that you should know whether the amount of oil supplied comes within the proportions referred to in the patent in suit. As a matter of fact, would you know, under these circumstances, whether the amount of oil supplied came within the proportions referred to or hinted at in the patent in suit?

A. I think I should, if I were operating a plant. I think the results would show it. Of course, if one, in a continuous process, introduced what he believed to be the proportion of oil suggested in the patent from time to time, he would naturally watch the operation to note whether the separation of metalliferous minerals from the gangue was proceeding satisfactorily. If anything occurred to indicate that it was not, he would use his experience and add a little more or a little less oil from time to time.

101 X Q. In referring to the ore mentioned in the passage beginning at line 72, page 1, of the patent in suit, in which passage no reference to the proportion of metalliferous mineral occurs, you have stated that the patentees have described that ore with as great precision as is possible, and you have also stated that if one is

221 going to purchase an ore, he should know its value and the kind and percentage of valuable material in it. If it is possible to state the kind and percentage of valuable mineral in an ore to indicate its value, would it not have been possible for the patentees, in order to set forth some one specific illustration of their process, to have stated the percentage composition, in so far at least as the metalliferous material is concerned, of the ore mentioned by them, or at least of that sample of the ore which they cite as an example of their process?

A. The patentees might, of course, have given a concrete statement of pecuniary values in some particular case, but, of course, the financial advantages of a process depend upon so many local conditions that it does not seem to me there is any particular advantage in doing so, and I can't recall a patent specification in which any such statement has been made.

102 X Q. Would an ore consisting of approximately twelve per cent. chalcopyrite, fifteen per cent. pyrite, sixteen per cent. carbonate of iron, sixteen per cent. dolomite and calcite, and thirty-seven per cent. other gangue minerals, be such as could be treated by the process which the patent in suit purports to describe, that is, successfully treated?

A. I don't know.

103 X Q. What would be your judgment as an expert upon this question?

A. I have no right to express an opinion.

222 104 X Q. Have you any opinion on this subject?

A. If you want me to guess, I will tell you the thoughts which are passing through my mind at the present moment. In operating with an ore of the composition you mention and using the amount of acid suggested in the patent in suit, the calcite and dolomite present would be likely to neutralize the acid, but, inasmuch as the acid is added simply to facilitate the process and diminish the probability of the gangue mineral appropriating some

of the oil, it is not impossible that such an ore might be successfully operated by the process of the patent in suit. Those are the thoughts which come to me in attempting to answer your question.

105 X Q. Your answer, I presume, is based upon your expert knowledge of the metallurgical art and chemistry?

A. It is. But it must not be forgotten that my experience with this particular process is based upon laboratory experiments with ores of the defendant.

106 X Q. If you found, as a result of experiment in treating the ore last referred to by us, that you succeeded in obtaining a froth, foam or scum containing a large enough percentage of the valuable components of the ore to be commercial, would the operation so performed come within the description set forth in the patent in suit?

A. I think it would.

107 X Q. Carbon dioxide would be generated, would it
223 not, by the action of sulphuric acid upon the dolomite and calcite contained in the ore last referred to by us?

A. None of any consequence, because the quantity of acid recommended by the patent in suit is so small and carbonic acid gas is soluble in water. If a minute quantity of carbonic acid gas should escape, it wouldn't modify the character of the process. The process would still be substantially the process of the patent, because the amount of carbonic acid gas which could possibly be liberated would be practically insignificant as compared to the amount of air which would be forced into the froth.

108 X Q. Is it your opinion as an expert in this art that, if the test referred to by Mr. Nutter were carried out in a bottle, as he describes it, with an ore containing substantial amounts of carbonate, oleic acid or other oily matters, and a mineral acid such as sulphuric acid being used, the resulting froth, in case a froth appeared, would be caused by the air introduced by shaking the bottle and agitating its contents, rather than by reason of the carbonic acid gas evolved by the action of the mineral acid upon the carbonate? I refer to the experiment or test described by Mr. Nutter in answer to 50 X Q.

A. I should infer that, if that experiment were made on the lines of the specification of this patent, that the resulting froth would be caused by the air introduced by shaking the bottle. Mr. Nutter has himself stated that he would make the experiment with or
224 without mineral acid in order to see which set of conditions gave the best result and that he would vary the temperature.

109 X Q. Do you consider that the conditions set forth by Mr. Nutter are within the terms of the specification of the patent in suit?

A. I do; especially considering the fact that this is only a field experiment, made for the purpose of getting preliminary information with regard to the nature of the ore and not for the purpose of regulating the process to be employed in metallurgical works.

110 X Q. Don't you think that preliminary tests would indicate the character of the operations to be performed in actual metallurgical operations?

A. Only approximately, because in the field it would be very difficult, if not impossible, to get an average sample of the ore.

111 X Q. But knowing the difficulty of getting a representative sample of the ore, don't you think that a preliminary test should indicate the character of the actual metallurgical operations to be performed?

A. Such preliminary test would undoubtedly give information of more or less value, but I do not think any intelligent person skilled in this art would plan his metallurgical operations with no more information than he obtained from a field experiment.

112 X Q. Do you think that any more exact or reliable information could be secured from the operation of the slide machine to which you have referred?

225 A. I do, because the slide machine is employed on what purported to be the ore actually in use in defendant's works.

113 X Q. I am not referring to any particular use of the slide machine, but to its utility generally as affording an indication of what will take place in actual metallurgical operations upon a commercial scale. With this explanation will you answer the question?

A. If the slide machine is employed on a fair sample of the ore, I think the results are entirely reliable.

114 X Q. Have you ever made any comparison between the results secured by the slide machine and secured in actual commercial operation?

A. I have not.

115 X Q. Then you cannot say definitely as to the question of whether the slide machine affords an actual indication of what would take place in actual operation commercially?

A. I think that in the result of the experiments made on the average ore, using 400 grams or nearly a pound of ore in each experiment, particularly when six such experiments made in succession are completely successful, the slide machine does afford an actual indication of what would take place in actual operation commercially.

116 X Q. If you obtained uniform results with the bottle test described by Mr. Nutter, would you consider that uniformity an indication that the bottle test was fairly representative of what would take place in actual commercial operation?

226 A. If the uniform results were satisfactory and the ore operated upon was a fair average sample, I think I should, though I have never myself made any bottle tests.

117 X Q. Do you find anything in the patent in suit describing the nature of the "simple preliminary test" refererd to in lines 65-67, page 1?

A. All I find with regard to this test is that the object of it is to ascertain what oily substance yields the proportion of froth or scum desired. Of course, this paragraph is offered to persons skilled in the art and I think it goes without saying that any person skilled in the art in making a preliminary experiment, would not only test different oily substances, but he would also seek to get what other desirable information he could from his experiment and would naturally observe the proportion of oil and acid which gave the best results.

118 X Q. Will you explain why warming quickens the action of the oil, as you have stated it does?

A. Possibly because it makes the oily material thinner. Possibly because the affinity of the metalliferous mineral for oily matter is increased by heat. There may be other reasons which do not occur to me.

119 X Q. From your testimony I understand that you have never seen the Cattermole process, referred to in the patent in suit, carried out with oleic acid. Is that correct?

A. I have not.

227 120 X Q. Do you know the percentage of savings of valuable mineral which was effected in the demonstration of the Cattermole process which you witnessed?

A. No, I didn't attempt to find out. My only object was to satisfy my curiosity and see the granules; what they looked like and how they behaved.

Cross-examination closed.

Redirect examination.

By Mr. Williams:

121 R. D. Q. In your answer to 38 X Q. you have called attention to the fact that, in your experiments, you were constantly reducing the amount of acid present by carrying off some of the water with each froth. Please give me a more definite notion as to the amount of water carried off and the dilution of the acid solution which resulted therefrom, having in mind that four successive layers of froth had been removed.

A. I began the experiment with 1,600 grams, equivalent to 1,600 cubic centimeters, of water, containing 30 cubic centimeters of five per cent. sulphuric acid. That liquid must have contained one and one-half grams of sulphuric acid, which is equivalent to 0.0937 per cent. The amount of liquid drawn off with the foam or froth is 430 cubic centimeters each time. For convenience of calculation, I will call it 400 C. C., which is one-quarter of the liquid present, this water being replaced by fresh water. One-quarter of the acid is therefore removed with the first froth, leaving three-quarters of the original quantity, which would be 0.0702 per cent. of the water in

228 the machine. After the second froth was drawn off, three-quarters of the last amount would remain; that is, 0.0527 per cent. I then added 10 C. C. of the five per cent. sulphuric acid, which increased the acid present to 0.0837 per cent., agitated and drew off the third froth; leaving the percentage of acid as 0.0632. I then added 10 C. C. of acid, making the percentage 0.0944. I then drew off the fourth froth, leaving the percentage of acid 0.0706.

Redirect examination closed.

Deposition closed.

CHARLES F. CHANDLER.

It is stipulated that if Floyd J. Metzger were called as a witness he would testify that he worked with the last witness and alone in the making of the analyses in the manner testified to by the last witness as having been made by Floyd J. Metzger and this stipulation shall have the same force and effect as the testimony of said Floyd J. Metzger in the particulars referred to, the right of cross-examination being waived.

It is stipulated that if Oscar Spitzer and Henry D. Williams were called as witnesses, they would testify that the specimen of defendant's concentrate, referred to in the testimony of the preceding witnesses, was delivered by registered mail at the office of the said Henry D. Williams and was opened by the witness, Dr. Charles F. Chandler,
229 in the presence of the said Henry D. Williams and Oscar Spitzer on August 18, 1911, and that the seals and marks were intact before it was thus opened. This stipulation shall have the same force and effect as the testimony of the said Oscar Spitzer and Henry D. Williams in the particulars referred to, the right of cross-examination being waived.

It is stipulated that the defendant in the practise of a process of separating the constituents of ores by flotation at Basin, Montana, prior to the commencement of this suit, added sulphuric acid and commercial oleic acid, commonly known as candlemakers' red oil, to the pulp containing the material operated on, but no stipulation nor admission is made as to the quantities of sulphuric acid and commercial oleic acid so used.

Complainants close their prima facie testimony.

230 *Certificate of Special Examiner.*

United States District Court, District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, and MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, Complainants,

vs.

JAMES M. HYDE, Defendant.

STATE OF NEW YORK,
County of New York, ss:

I, Bernard Cowen, a Notary Public in and for the County of New York, hereby certify that the foregoing depositions of Edward H. Nutter and Prof. Charles F. Chandler were taken before me at the office of Henry D. Williams, Esq., 76 William Street, New York City; that the deposition of Edward H. Nutter was taken on February 15, 16, 17 and 19, 1912, and that the deposition of Prof. Charles F. Chandler was taken on February 20, 21, 22, 23, 24 and 27, 1912; that for the purpose of taking such depositions I acted by agreement

of counsel as Special Examiner under the 67th Rule in Equity
231 as amended; that during the taking of said depositions the complainants were represented by their counsel, Henry D. Williams, Esq., and the defendant was represented by his counsel, J. Bruce Kremer, Esq., and Walter A. Scott, Esq.; that before each witness gave his deposition the said witness was duly sworn by me and his deposition taken down on the typewriter in the presence of counsel for both parties, and that, at the conclusion of his said deposition, the same was signed by the witness in my presence.

I further certify that I am not of counsel for either party to this cause, nor related by blood or marriage to any member of either of the complainant corporations or the defendant, and that I am not interested directly or indirectly in the matter in controversy.

In Testimony Whereof, I hereunto set my hand and notarial seal this 28th day of February, 1912.

[NOTARIAL SEAL.] BERNARD COWEN,
Notary Public, New York County.

232 United States District Court, District of Montana.

In Equity.

No. 1076.

MINERALS SEPARATION, LIMITED, and MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, Complainants,

vs.

JAMES M. HYDE, Defendant.

Depositions of witnesses in behalf of complainants in rebuttal in the above-entitled suit taken pursuant to a Commission issued out of the above-entitled Court July 6, 1912, before Joseph Phillips Crawley of 9 Bishopsgate, London, England, a Notary Public and the Commissioner named in said Commission and acting also with the consent of counsel for both parties hereto, at the office of Boult, Wade & Tennant, 111/112 Hatton Garden, Holborn Circus, London, E. C., commencing this 22d day of August, 1912, at 11 o'clock in the forenoon:

Present: Henry D. Williams, Esq., Counsel for Complainants.
Walter A. Scott, Esq., Counsel for Defendant.

233 GEORGE ALBERT CHAPMAN, a witness produced on behalf of the complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. What is your name, age, residence and occupation?

A. George Albert Chapman, age thirty-one, of Newton Hotel, Holborn, London; I am by profession a metallurgical engineer and assayer. My business address is care Minerals Separation, Limited, 62 London Wall, London, England.

2 Q. By whom are you employed and what is the nature of your work?

A. I am employed by the Minerals Separation, Limited, in carrying out tests on ores, investigating processes, erecting, directing and operating plants in various parts of the world.

3 Q. Please briefly outline your technical education and experience.

A. I received my technical education at the Battersea Polytechnic, London, S. W., where I was a student for five and a half years. I received instructions specially in the subjects of chemistry, physics, metallurgy and engineering. In 1899 I entered the services of Mr. Henry Livingstone Sulman, at that time of 60 Gracechurch Street, London, E. C. My first employment there was as assayer and general metallurgical assistant. In 1900 I was specially ap-
234 pointed as assistant to investigate and carry out tests by the bulk oil Elmore process, under the direction of Messrs. Sulman & Picard and Ballot. About this period also I conducted trials on the Robson & Crowder process which is an oil-washing process of ore extraction. On Mr. Cattermole's introduction to the firm I acted as his assistant and finally in Mr. Cattermole's absence I assumed his duties. About this time I was appointed by Messrs. Sulman & Picard to carry out tests, under their instructions, on the Wolf or Scammel process. At a later period I was engaged chiefly in investigating the Froment process and later still the Sulman & Picard bubbles and skim-flotation processes, the Cattermole, Sulman and Picard Soap process. This brings me to the end of 1903.

4 Q. Please describe the manner in which you carried on your investigations or tests on the Froment process?

A. I will answer this question in two parts. Firstly, I carried out tests with the apparatus sent by Mr. Froment to London. I only used the first two portions of the apparatus forwarded, namely, the agitator and the separating pan. It required very few tests to demonstrate that the apparatus was entirely unworkable, and I abandoned using it. The ore used in this series of tests was Broken Hill crude ore, crushed to 80 mesh to which was added ten per cent. of crushed calcite. My reason for not using the third part of the apparatus was that it was too large to be conveniently erected in Messrs.
235 Sulman & Picard's laboratory. To get an idea of the merits of this portion of the apparatus I tried many tests on small

screens under the conditions suggested by Mr. Froment. These screen tests determined that this latter part of the apparatus was also unworkable. Only by the most careful nursing were any flocks of mineral persuaded to remain on the screen.

After consultation with Messrs. Sulman & Picard I determined to make every effort to get this process to work in some simple and practical manner. For the agitation part of the process I used one of the Gabbett or cone mixers installed in the laboratory. I usually took 1200 cc. of water and 500 grams of crushed Broken Hill crude ore to which was added varying quantities of oil from 60 lbs. per ton to 120 lbs. per ton. The pulp was vigorously agitated until the metalliferous sulphides were coated with the oil. The only method by which I could obtain a satisfactory separation of the sulphide mineral from the worthless gangue was to take the charge from the Gabbett or cone-mixer and allow it to stand in a basin for settlement. The clear liquid was decanted off, and a thick mud remained in the basin. To this thick mud was added ten per cent. of finely crushed calcite, which was thoroughly mixed by stirring with a spatula. The charge was then placed upon a plaque in small portions, say of about fifty to sixty grammes. The plaque was then placed beneath the surface of slightly acidulated water. The acid attacked the calcite,
236 and this had the effect of causing the sulphide mineral to separate itself from the gangue in the form of flocks of pasty oiled mineral. These masses of mineral did not always float to the surface of the acid liquor, but the attached gas bubbles caused these flocks to be comparatively lighter than the gangue, and in this condition they could be easily separated by a simple vanning. The plaque was withdrawn with the gangue contents and the mineral collected from the vessel containing the acid liquor. The concentrates recovered were therefore separated in two distinct manners: First, the portion of the concentrate that were lifted bodily by the gas to the surface of the liquor, and secondly the portion of the concentrates that were rendered light by the gas association which were vanned by the usual well-known methods. By this latter method fairly good separation of sulphide minerals was possible, and in my opinion this is the only method by which the difficult Froment process can be made to give any resemblance to a practical separation.

5 Q. Please describe the manner in which you carried on your investigations or tests on the Sulman and Picard Bubbles process?

A. Under Messrs. Sulman & Picard's instructions I carried out a large number of trials investigating this process. Part of the work was carried out on the lines given in the latter portion of my answer to the last question. Considerable time was spent in constructing a small glass apparatus of the type given in Figure 1 of Patent No. 793,808. This was made of glass to enable a full view to be
237 had of the separation. The tailings from the Cattermole process containing sunken flocks of mineral were placed in the apparatus and air pumped into a perforated spiral, which was rotated slowly. The results from this apparatus were most encouraging. This apparatus was also used to bring about the Froment effect. The Cattermole tailings were mixed as described before with ten per

cent. of crushed calcite, and instead of passing air through the perforated spiral a solution of weak sulphuric acid was introduced into the separating vessel by this means. Good flocks of mineral separated from the gangue, many of which, although carried up to the surface of the liquor, did not break through the surface film. The associated gas bubbles detached themselves and the mineral sank and became mixed with the residue of tailings.

Another type of apparatus used took the form of an ordinary scent spray. This apparatus was used in several manners. First it was used to force finely disseminated oil into a vessel containing crushed ore and water. This method of bringing about oil attachment to the sulphide mineral proved to be very poor. Second, a pulp of crushed ore and water, which had been suitably agitated with oil, was placed in the scent spray. The pulp was sprayed on to the surface of still water. A separation of the sulphide mineral from the gangue was quite apparent, the mineral floating by means of the well-known oiled needle effect and the gangue sinking through the water.

238 6 Q. You have also mentioned the Sulman & Picard skin-flotation process. Please describe the investigations on this process?

A. This process was being investigated by other assistants of Messrs. Sulman & Picard and I recollect doing no systematic work with this. I have referred to Patent No. 793,808 to refresh my memory.

7 Q. You have mentioned the introduction of Mr. Cattermole to Messrs. Sulman & Picard and that you acted as his assistant.. What work did you do as his assistant, and with what process or processes?

A. We were chiefly concerned in testing ores by the granulation or Cattermole process. The apparatus used to carry out this process consisted of a series of gabbett or cone-mixers, which were six in number for the first agitation. This first agitation was of a very violent type to bring about the oiling of the sulphide mineral. The agitated pulp was then passed to a small glass upcast separator where the fine gangue slimes were washed from the pulp, allowing only the oiled metalliferous particles and the coarse gangue to pass to the second stage of the process, which consisted of slowly rolling in the same type of mixer as used in the first stage, but with the baffles taken out and the speed of the cone much reduced. This slow rolling had the effect of causing the incipient granules to make combination amongst themselves, and the rolling was continued until the mineral worked into the form of hard shotty granules. In the second

239 stage of the process it was highely important to prevent air attaching itself to the mineral, and this was the reason for taking the baffles out and reducing the speed. After the slow rolling, the treated pulp then passed to a second upcast classifier where the gangue was washed from the shotty granules. The granule product usually carried only about 3 per cent. of insoluble gangue matter. First investigations determined that the granule formation in the slow rolling stage was much improved if the fine slime gangue was removed before this stage of the process was reached. Excellent results were obtained by this method, and on Broken Hill crude ore we on

many occasions obtained 90 per cent. recovery of the three valuable metals, namely, silver, lead and zinc. After the success of this process was fully established in the experimental stage we were chiefly concerned in devising a breaking-down method to separate the mixed concentrate of galena and blende into the more saleable separate lead and zinc concentrates.

I was assisting Mr. Cattermole in this work when I was called upon to take up other investigations.

8 Q. Please continue as to your further work with the Cattermole process so far as you carried it on in England.

A. In or about December, 1903, I was instructed by Messrs. Sulman, Picard & Ballot to erect a small Cattermole plant, of the type described in my last answer, for the purpose of installation in Australia to carry out tests on the ore and mill products of the
240 Sulphide Corporation, Central Mine, Broken Hill. This plant was erected at the works of W. M. Still & Co., Charles Street, Hatton Garden, London, under the superintendence of my intsructors. The photograph marked for identification "Photograph Australian Cattermole Plant" is a photograph of this plant as it was erected prior to dissembling and shipment to Australia. This plant was thoroughly tested before taking it to pieces for shipment, and it was at the period of these tests that I was first introduced to Mr. A. H. Higgins, who acted as my assistant in the final London trial. We satisfied ourselves that good results could be reproduced with this plant and on reporting this I was immediately instructed to leave for Australia.

By Mr. Williams: The photograph referred to by the witness in this last answer is offered in evidence and marked "Complainants' Exhibit, Photograph Australian Cattermole Plant."

9 Q. In testing this plant at Still's, did you at all times use all of the apparatus, and generally what proportion of oil and what kind of oil did you use?

A. In several of the trials with this apparatus we did not use the last two mixers marked "8" and "9" on the photograph, as the residues or tailing from these tests were very clean and required no form of re-treatment. The ore used was Broken Hill crude ore of 55 per cent. mineral content. The proportion of oil used and set as a standard for future work was five per cent. on the sulphide mineral
241 constituents or mineral content of the ore. The oil was added in the form of an emulsion, which emulsion usually carried 33% of actual oil and consisted of 3 parts of Roumanian thick residuum to one part of ordinary paraffine or kerosene. Of course other oils were frequently used, both in the form of straight oil and in the form of emulsion, the type of oil addition being determined by the amospheric temperature on the day of test. Oleic acid was very often used.

10 Q. How about what is referred to as "oleic soap"?

A. Oleic soap was a convenient form of oil addition and as such was very often used in our tests. Immediately the soap solution came

in contact with the acidulated water oleic acid was liberated in a form most suitable for the process.

11 Q. Did oleic soap appear in any of the emulsions that you have described, and please state how these emulsions were produced?

A. All our later work was conducted on emulsions containing oleic soap. These emulsions were produced by mixing a soap solution with the oil. In most of these emulsions the amount of soap was roughly one-tenth of the total quantity of oil, which was usually 33.3 per cent. of the total emulsion, the rest being water.

12 Q. When emulsions were produced without oleic soap, what were the constituents and what was the procedure necessary to produce these emulsions?

242 A. Ordinary soft soap solution was substituted for the oleic soap solution and the other constituents were as before, oil and water.

13. Q. In your answer to 3 Q. you referred to the Cattermole, Sulman & Picard soap process. What did you do in connection with this process?

A. In connection with the work on this process we took advantage of the soap phenomenon in which, when it came into contact with the acid liquor, the oleic acid was produced in situ. This was used in the Cattermole process as I have described. The second part of the process was merely a means of attempted recovery of flocks of mineral that had passed over with the gangue from the upcast and had sunk. We took advantage of the Froment effect in this latter portion of the process. Although at times we had indications that were encouraging, no practical good resulted from our efforts to make this latter part of the process into a commercial process. This soap process was applied to the treatment of the crude ore direct without the intervention of the Cattermole separation and total flotation attempted. The results however were most discouraging and work was stopped on these lines.

14 Q. In the last sentence of your last answer it is not quite clear in what manner the soap process was applied to the treatment of the crude ore direct, without the intervention of the Cattermole separation, that is to say, whether it was as you have described with

243 the Froment effect, or without the Froment effect. Please explain more fully.

A. Oleic soap was added to the crude ore and water in the Cattermole proportions and agitated in the usual manner up to the first upcast. The pulp from this was taken and a Froment separation attempted in the manner in which I have described previously.

15 Q. When did you go to Australia for the purpose of installing the Cattermole process there,

A. I left England for Australia in or about April, 1904.

16 Q. And when you reached Australia what was the first thing that you did?

A. I cleared the plant through the Customs and re-erected it on the property of the Sulphide Corporation, Central Mine, Broken Hill.

17 Q. Was this plant again tested after it had been re-erected?

A. After the erection was completed I started testing the plant with crude ore from the mine crushed to 60 mesh. All the tests which I carried out were in the presence of Mr. J. Dreyer, who was metallurgist to the Company. Mr. Dreyer checked all weights and samples on behalf of his Company.

18 Q. Were these tests satisfactory?

A. The tests were most successful, and on the result obtained our clients immediately proceeded with the planning and erection of a plant built on identical lines with the smaller unit which had
244 been tried. The new plant was to have a capacity of 100 tons per day of twenty-four hours.

Q. 19. Please describe the agitating or mixing vessels that were used in this 100 ton plant when first erected.

A. We attempted to follow out the line of the Gabbett or cone mixers used in the small plant, and the large scale Gabbett agitators were in exact duplication of the smaller mixers, except that they were made of wood, and the mixers had flat bottoms instead of the rounded bottoms in the mixers of the smaller unit. To the side of the circular vat were fastened triangular strips of wood to take the place of the wire baffles used in the smaller mixer. A nest of six mixers connected by a pipe about six inches from the bottom of the inside of the vat constituted the first part of the plant in which it was desired to give the ore pulp a violent agitation with the added oil or emulsion.

20 Q. Then, from these six mixing vessels on, what were the other apparatus?

A. At the end of the first six mixers a small upcast was in position to separate the slime gangue to bring the pulp in the condition desired for the slow rolling in the second tier of mixers, in which there were three mixers, again a duplication of the agitators of the first series, except that the baffles were removed and the cones were much reduced in speed. From these the pulp passed to another upcast separator. Below the second series was another nest of two agi-
245 tators, in which baffles were fastened and the cones again speeded up. The pulp passed from these last two agitators and was divided by simple launders to feed four Wilfley tables, upon which the riffles were modified. The object of the tables was to recover by skin-flotation effect any mineral flocks which had been lost with the gangue product.

21 Q. Was this plant completed and put to work, and if so, when?

A. This plant was completed and adjustment runs made in or about April, 1905.

22 Q. And after these adjustment runs was it put to work treating ore, and if so, for how long?

A. We started the plant on dump tailings, and treatment proceeded along the Cattermole line for but a few days. The oil consumption alarmed our clients, and I was instructed to use every endeavor to bring this down. This was only possible to the extent of .8 per cent. on the weight of the ore. The formation of good shotty granules was impossible under these conditions, mineral flocks being formed, and these readily separated on the skin flotation table on the lines in which I had been instructed by Messrs. Sulman, Picard and Ballot

previous to my departure for Australia. These trials took considerable time, and it was a few weeks before this best condition was reached. The plant proceeded to run on these lines.

23 Q. What next happened which brought about any change in this plant?

246 A. In or about the month of June I received instructions from Mr. C. F. Courtney, general manager of the Sulphide Corporation, to modify the plant so that we could take advantage of a very important discovery that had taken place in England. He handed me a drawing which gave the details of the process which was exactly the same as the drawing marked for identification "Sulman Drawing accompanying report May 3, 1905." Owing to the trouble which had been met with in working our previous method, as a practical man, I was very much gratified and relieved to know that we could substitute this more simple and ingenious process.

24 Q. What did you do with the plant when you received these instructions?

A. In the position occupied by the second tier of mixers a spitz box was placed into position. A connecting launder from No. 6 agitator of the first nest to the spitz box was introduced. The bottom outlet of the spitz box was connected to our previous table arrangement so that we could take advantage of skin flotation effect to recover any mineral that had been lost in the first separation. This is identical with the scheme suggested by the drawing. A steam pipe was introduced into the first and last mixer of the only tier now in use. The plant was started up under these conditions, and the pulp received a violent agitation, and was passed down the launder to the spitz box. On the surface of the spitz box, at a point where

247 it was perfectly tranquil, a substantial froth formed. This was entirely different to any float that I had seen in the other processes in which flotation had been attempted. This froth had many characteristics, and the most important difference I noticed in comparison with the other floats was that the froth was of the same color as the mineral and of the same lustre. This had never been so in the other cases, where the oil had considerably dulled the natural color and lustre. The froth consisted of air bubbles, with water films that were highly charged with sulphide mineral. These bubbles could not retain their natural spherical shape, owing to the crowding together of the froth mass. The upper layers of bubbles, when they broke, deposited their charge of mineral on to the bubbles beneath. This gave the froth a pitted or scoriated appearance. The depth of the froth at the point of overflow was quite three inches. The froth was so coherent and substantial that it would readily support a coin, which it would carry over the overflow lip without breaking through the mass. We used this to demonstrate to visitors at a later date. The tailings from the spitz box then passed to the tables for re-treatment, where many types of air jets were applied in the hopes of improving the recovery. The work on these tables was never really satisfactory, and an examination of the tailings showed the sulphide mineral losses to be in the form of a potential froth. A few experiments showed that it was only necessary to give these

a slight agitation to bring about further air-bubble attach-
248 ment, and this potential froth then became a real froth on passing it to another spitz box. This second spitz box was placed immediately below the first spitz box, and the tailings were brought with a good splash on to suitable baffles and boards of the second spitz box. From this date onward the tables for the retreatment of tailings from flotation treatment were discarded.

25 Q. What amount of oil to the ton of ore did you use when the plant was changed to collect the mineral in the form of a floating froth as you have described?

A. We used two pounds of oleic acid per long ton of ore.

26 Q. At the time that you changed the Cattermole plant to a froth separation plant what form of agitators did you use in the mixing vessels, six in number, which were then used?

A. We retained the same Gabbett or cone mixers that were used in the first treatment of the Cattermole process plant.

27 Q. Were any changes made in the form of the agitator, and if so what were these changes?

A. Yes. Owing to the high consumption of power by the cone form of agitator we introduced first a centrifugal stirrer which consisted of circular sheets of metal held together by radial arms or ribs, the lower sheet of metal being an annulus. This enabled the pulp to be drawn in to the stirrer and thrown violently
249 against the sides of the circular vat and baffle. The wear and tear of this type of agitator was considerable and it was necessary for economy of maintenance charges to devise a more lasting type of agitator. We then tried the ordinary four-arm agitator, the blades of which were right-angularly fixed, a cross-section of the blades showing the height to be several times the width. This form of agitator was a great improvement on the other types which had been tried, but they wore badly at the end of the blade in a radial direction rearwardly. This suggested a type of agitator where the four blades were so radially curved rearwardly and these were strengthened by ribs on the back of each arm. This type of agitator was in use for some considerable period. We then attempted to increase the aeration by a type of agitator in which the arms were diagonally fixed. Two blades were inclined in the direction so as to beat the agitated pulp downwardly and two were fixed so as to beat the agitated pulp upwardly. These changes in the type of agitator had been very effective in their saving of power, fully 60 per cent of the previous consumption being saved.

28 Q. Was the operation of the plant interrupted in the making of these changes in the form of the agitators?

A. No. The alterations were always completed during our Sunday stop.

29 Q. What changes if any were made in the form of the agitating vessels themselves from the wooden vat form that you have described?

250 A. In all the new plants that we erected we discarded the circular vat and instead used the ordinary square box agitator, a type recommended by Gabbett.

30 Q. What were these new plants that you erected in Australia?

A. The No. 2 Flotation Plant at the Central Mine, Broken Hill; the Slimes Treatment Plant on the extended lease of the Sulphide Corporation, Limited; the Zinc Section New Mill, and the Minerals Separation Tailings Plant, both of which were on the property of the Sulphide Corporation Ltd. These had a total capacity of over ten thousand tons per week.

31 Q. When the No. 2 Flotation Plant at the Central Mine was erected, what became of the first plant which you have heretofore described? Was its use continued or abandoned?

A. The plant was abandoned for the more simple type which allowed a very big reduction in the working costs.

32 Q. About when were these four successive plants, which you have described, erected and put at work?

A. The plants were erected concurrently in the year 1907. The Zinc Section New Mill started treatment first, followed in about two months, if my memory serves me correctly, by the Slimes Treatment plant. Almost on the same day the No. 2 Flotation Plant was completed and the No. 1 Flotation Plant shut down. In or about September of the same year the Minerals Separation tailings plant commenced treatment.

251 33 Q. You have said that in all these new plants the ordinary square box agitator was used in place of the circular vat of the No. 1 Flotation Plant. In what other substantial respects, if at all, did these several plants differ from the first flotation plant which you have described and referred to, I take it, as the No. 1 Flotation Plant?

A. The Zinc Section New Mill was a plant which absorbed all the tailings and slimes rejected from the lead concentrating mill, the ore therefore being delivered suitably crushed, namely, to half a millimetre and with all its slimes. In general design the construction of the plant building was of a much improved and more economical type. The main points of the plant used in carrying out the process were practically the same as adopted in the No. 1 Flotation Plant, except that in this case it was found necessary to have three spitz boxes in series instead of two, the third one being under the second and was rendered necessary by the increased tonnage being treated. On many occasions it was unnecessary to use this third box and it was only under abnormal conditions that any mineral was recovered by the extra box. The Slimes Treatment Plant was a plant erected to treat the dump slime of the Sulphide Corporation, Central Mine, and the Broken Hill Proprietary Block 10 Company, Limited. In the Slimes Treatment plant the thickness of froth very often reached five or six inches and it was necessary to slightly increase the area of the spitz box. Owing to

252 some peculiar condition this thick froth discharged itself from the box very badly and it was necessary to introduce a small four-arm paddle device which revolved slowly and assisted the froth over the lip. Owing to the very slimy nature of the feed it was necessary to restrain the froth overflow as much as possible so

that no free liquor passed over the lip with the froth. This was to bring the proportion of gangue in the recovered concentrate to a minimum. The heating of liquors used in this plant was to a large extent done by the exhaust steam from the mill engine being suitably applied. The tailings from the first spitz box were passed to a second tier of agitators where the pulp was re-agitated. The re-agitated pulp passed by launder to a series of two spitz boxes placed one below the other in the usual manner. The feed to this plant, consisting as it did of dump slime, was sufficiently powdery for the treatment by the frothing process. It was only necessary to pass the dump slime through a clay puddler with a little water to break up the large lumps. The first agitator of the plant was sufficient to completetly break up the pasty slime and thus render it in the condition desired. A breaking down section was also attached as an annex where it was attempted to separate on Krupp Ferraris tables and Frue vanners the mixed concentrate into the more saleable lead and zinc concentrate. The work on this plant was very good, but owing to more suitable contract being made for the sale of the mixed concentrate, this breaking down section was
253 shut down as it had then become unnecessary to separate into the two concentrates.

The No. 2 Flotation Plant and the Minerals Separation tailings plant were, as far as the application of the agitation-froth process was concerned, identical. The design of the crushing plant was slightly different, but the principle adopted was almost identically the same. In both these last two cases the treatment section followed out the design of the Zinc Section New Mill.

34 Q. Who superintended the construction of these five plants that you have described?

A. Mr. Stanley Woodman, resident engineer of the Central Mine, was directly responsible for the labor employed in the erection of the plants, but the design of these plants was the result of a conference between Messrs. Courtney, Hebbard and myself. I superintended the construction.

Adjourned to Friday, August 23d, 1912, at 10:30 A. M., at the same place.

London, August 23d, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination of Mr. Chapman continued:

35 Q. What was the consumption of oil per ton of ore in these several plants which you have described?

254 A. The consumption of oil was about one and a half pounds per long ton of ore.

36 Q. Were these plants operated successfully and profitably?

A. All these plants were a great success and considerably influenced the increased profits earned by the Sulphide Corporation Limited in the past few years.

37 Q. Did you have anything to do with the erection of a plant for carrying on the agitation froth process at the Zinc Corporation, and if so, please state what was done by you in relation to the planning and erection of this plant?

A. Early in 1907, I was consulted by the then superintendent of the Zinc Corporation Works at Broken Hill, namely, Mr. Erle Huntley, who confirmed the information already given to me by Mr. Courtney, in stating that the Zinc Corporation Limited intended to install the agitation-froth process. Acting on instructions from Mr. Courtney I visited the Zinc Corporation existing plant which was then operating the Potter process. After consultation with Mr. Huntley he instructed me to assist him by preparing plans for changing over the Potter process to the agitation-froth process. I submitted to him plans of the works then in progress on the Central Mine, Broken Hill, which gave full details of the type of Babbett mixers then in use and the spitz boxes. It must be fully understood that I advised him only in regard to the treatment section, that is, that portion of the plant that was actually to operate the agitator-froth process.

255 To speed up the change of treatment process I arranged with Mr. Hebbard to allow us to use the spare spindles and agitators that we had in stock, in the store of the Central Mine. The erection of the plant was done by the officers of the Zinc Corporation Limited. When the plant was ready I impressed upon Mr. Huntley with considerable emphasis the necessity of submitting to our treatment a suitable feed, namely, that the crude tailings should be crushed to a half millimetre in size and be fed regularly with all its slimes to the treatment plant. Other points, such as the thickness of pulp, acid and oil addition were fully discussed and explained to Mr. Huntley and his metallurgists. So that no time should be lost in getting the plant into good working swing I drew upon my own crews of men, then working on the flotation plant on the Central Mine, and lent them sufficient men to run their flotation plant until such time as they had trained their own crew.

38 Q. Was this Zinc Corporation agitation-froth process plant installed and operated in accordance with your instructions, and was it installed as a satisfactory plant?

A. The feed and crushing arrangements of the plant were very poor and the crushing section produced a very badly crushed product. The arrangements for the regular addition of the slime with the grainy portion of the powdered ore were wretched and caused the treatment by the agitation-froth process to be at times

256 unsatisfactory. This was entirely due to the bad powdering of the ore and the wretched arrangements for a regular feed. The condition of powdered ore demanded as an essential need for our process was very rarely produced for our benefit. The crushing machines were totally inadequate for the tonnage being passed through the mill and were in a very bad state of repair. I can, therefore, definitely state that my instructions as far as the condition of the powdered feed were never carried out. My position only being an advisory one, I could only point out the mistakes being made, but was never given an opportunity to rectify them.

39 Q. This plant was planned to have what capacity?

A. The agitation-froth process section was planned to have a capacity of four hundred and eighty tons per day of twenty-four hours.

40 Q. What was the actual capacity of the crushing plant which supplied the feed for this agitation-froth process plant?

A. If the crushing section had been in good working condition and in a state of thorough repair, this section would no doubt have handled, to my satisfaction, about two hundred and ninety to three hundred tons per day.

41 Q. What did you see of the operation of this plant? Was it carefully run within the limitations of its feed, or was it forced beyond the capacity of the feed to supply powdered ore in such a condition as was required for the proper and successful operation of the plant?

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A. To fully answer this question I must point out that a few weeks after the agitation-froth process started operations for the Zinc Corporation, a change in their Broken Hill management took place and Mr. D. P. Mitchell assumed the position lately occupied by Mr. Erle Huntley. It was during Mr. Mitchell's regime that the plant was operated on tonnages sometimes exceeding five hundred tons per day. It was on very few occasions that all the machines of the crushing plant were working. Several stops were necessary, amounting on occasions to three or four hours per day, owing to shortage of boiler capacity. Irrespective of these stops, every effort was made by the management and its officers to exceed five hundred tons in the full day of twenty-four hours. On occasions dump tailings from the British Mine were passed through the treatment-section without first being powdered to the size required. These should have been reduced in size to a half millimetre, whereas in fact these dump tailings were the result of a three millimetre crushing, and received no further powdering. I called Mr. Mitchell's attention to this bad arrangement and again impressed upon him the absolute necessity of delivering ore for treatment by the agitation-froth process in a suitably powdered form. I reported the bad methods employed by our clients to our then consulting engineer, Mr. C. F. Courtney, and I suggested to him that the only way by which we could successfully operate our process for the Zinc Corporation was for us to assume charge of all the crushing and feeding arrangements. He opened negotiations with this object in view, and on the completion of the discussion it was agreed that this should be done. As soon as this arrangement was completed and details being planned, the Zinc Corporation Plant was shut down without notice, and treatment by the agitation-froth process discontinued for the time being. I reported on this very fully to Mr. Theodore Hoover by a letter dated August 16th, 1907, which I now produce.

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By Mr. Williams: The letter produced by the witness is offered in evidence and marked "Complainant's Exhibit Chapman, Report, August 16, 1907."

42 Q. I note in your letter under the heading of "High Tonnage" you say that "The breakages to plant caused delays of eight to twelve hours per day (average)." What parts of the plant are referred to here?

A. These stoppages were caused by shortage of boiler capacity, breakdown of feed elevators, and breakages to crushing plant, and were the result of the bad maintenance of the plant.

43 Q. At the time that the Zinc Corporation discontinued the use of the agitation-froth process plant which you have described, were there any other agitation-froth process plants in successful use at Broken Hill, and if so, name them?

259 A. The No. 1 Flotation Plant of the Central Mine Broken Hill, the Zinc Section New Mill was running for adjustment and I believe the Slimes Treatment plant had started operations, which operations were of the most successful kind.

44 Q. I call your attention to 33 X Q and answer in the deposition of Mr. Herbert C. Hoover, and ask you to state the actual facts, within your knowledge, as to the incident there inquired about?

A. On the occasion referred to, Mr. H. C. Hoover was in Broken Hill. The plant was run under his direction while I was present and operated on over five hundred tons per day. I repeated to him the constant warning that I gave to his Broken Hill superintendent, Mr. D. P. Mitchell, namely, that although the agitation-froth section of the plant was quite capable and efficient to handle successfully five hundred tons of correctly powdered feed per day, the crushing-section of the plant was totally incapable of correctly handling this large tonnage. Mr. Hoover replied that for certain reasons it was absolutely necessary for them to be able to cable home that the plant was operating on an average of five hundred tons of ore per day. I pointed out to him that if he forced the tonnage through the crushing section the recovery by the agitation-froth process would suffer. He assured me that for the time being this would not matter as the main point that they wished to confirm and prove was the capacity of the plant and the grade of recovered concen-

260 trates. When the standard set by Mr. Hoover, was reached, namely, treatment of five hundred tons of ore per day, and the production of a zinc concentrate assaying 46 per cent. zinc, he left Broken Hill for Melbourne. Before he left, however, he instructed me to consult with Mr. Mitchell, in order to bring the crushing requirements up to the standard desired. This I did with the results above stated.

45 Q. Mr. H. C. Hoover, has testified that Minerals Separation representatives in a general way had supervision of the operation of this plant. What have you to say as to this?

A. My position was only advisory and the first calls upon my time were in connection with the running and operating of this Sulphide Corporation Limited flotation plant. I visited the Zinc Corporation Works three and sometimes four times a day. I had trained men in the agitation-froth section and I was sure that with the correct addition of powdered feed they would reproduce the excellent results that were being obtained in the Plants erected on the property of the Sulphide Corporation Limited.

46 Q. Prior to the installation of the Zinc Corporation Plant referred to did you make any tests of their ore, and if so, with what result?

A. We carried out tests for the Zinc Corporation Limited in the No. 1 Flotation plant on parcels of tailings from the Broken Hill Proprietary Block 14 Limited, British Broken Hill Proprietary Limited, Broken Hill Proprietary Block 10 Limited and the
261 Broken Hill South Mine. These tests were carried out in the presence of Zinc Corporation representatives, namely, Messrs. W. E. Simpson, Quenceau, and Henry Lavers. They had a staff of about twelve men sampling the products as they left the agitation-froth plant. These tests have been fully reported and proved the points that the Zinc Corporation wished to try, namely, that the agitation-froth process was equally applicable to the products from other Broken Hill Mines and that under correct conditions of powdered feed the same good results could be obtained from the tailings that they had bought as could be obtained in the treatment of Central Mine tailings. The tests were very severe. Central Mine tailings were being operated in the usual manner and the various parcels of tailings were separately replacing a previous parcel without any stoppage of the plant. The only change in the plant was the adjustment of the reagents to suit the different parcels. A good coherent froth was obtained in every instance.

47 Q. I note that in your report of August 16th, 1907, to Mr. Theodore J. Hoover, which is in evidence, you state that this Report is "on the working of the granulation process on the British Mine." Please explain this?

A. As I have already testified the first large scale plant that I erected in Broken Hill was intended to operate by the Cattermole or granulation process. When the change over to the agita-
262 tion-froth process was made the name "granulation-process" was continued in use by the uninitiated. Even to this day in some parts of Australia our plants are still known as "granulation plants." I used this name because it was the name by which the plant was known.

48 Q. How long did you stay in Australia at work upon the various agitation-froth process plants installed there?

A. I left Australia in or about May, 1908.

49 Q. At the time that you left Australia in May, 1908, what plants were running wherein the agitation-froth process was used?

A. The Zinc Section New Mill, and The Minerals Separation Tailings Plant. To this I should add that owing to the enormous success of the Minerals Separation Tailings plant, and the larger tonnages than anticipated that were being treated, the concentrates produced for shipment were in excess of that required to fulfill our contracts to the smelters, and therefore the No. 2 Flotation plant was shut down and the concentrates contract taken over by the Minerals Separation Tailings Plant. I should point out that the later plant, namely, the Minerals Separation Tailings Plant, operated at a very much reduced cost. Nearly fifty per cent. of the total working costs were saved in the later and more compact ar-

rangement, the large tonnage also considerably assisting in this reduction.

50 Q. Can you give the Court any idea of the amount
263 in bulk of the accumulated concentrates from these plants at the time you left Australia?

A. There were about 450,000 cubic feet representing roughly 25,000 tons.

51 Q. You have said it is part of your work to carry out tests on ores. Please describe the manner in which you customarily test an ore for the purpose of determining whether or not it can be successfully treated by the agitation-froth process?

A. The ore to be tested is suitably powdered or pulverized. I usually use the Sulman & Picard Slide machine, sometimes known as a "shear-mixer." Into this Slide machine I place sixteen hundred grammes of water and in it place four hundred grammes of the ore to be tested. I add acid to equal twenty pounds per ton of ore to be tested and note the effect of such an addition. If a violent evolution of CO^2 takes place I know that calcite is present in the ore in disturbing quantities. By disturbing quantities I mean that the ore would require large quantities of acid in the treatment, and for economy's sake I abandon the test and use certain acid salts such as are advised in the Patent in Suit. The choice of oil for treatment is decided by the locality of the mine, and if possible I use an oil that is locally produced and is as cheap as possible. Having settled upon the acid condition I add roughly one and a half pounds of oil per ton of ore and agitate vigorously for about two minutes. The machine is stopped and the contents of the slide-machine examined.

If a good coherent froth is not formed I know that I have to
264 make some slight modification in the re-agents used. To any one well-trained in the agitation-froth process it is a simple matter to adjust the conditions so as to produce a good, thick, matted, coherent froth. The contents of the slide machine are allowed to stand still for about half a minute. This is to allow a settlement of the gangue slimes. The top half of the mixer is drawn and in its travel it carries the agitation-froth with it so that it can be suitably collected in a basin or other vessel. The machine is restored to its normal position and fresh water added to bring the total water up to sixteen hundred grammes as before. The pulp is then vigorously agitated, this time for about one minute. This is to allow any potential froth lost in the first step of the operation to become a real froth, so that it can be collected in the usual manner. I then examine the tailings and if necessary repeat the operation to attempt the production of more froth. By the examination of the tailings can be determined whether the oily re-agent has been added in excess, for I know now that any sunken mineral in the tailings is due to semi-flocculent granulation which can only be produced under these conditions. If such proves to be the case I abandon the test and start treatment with smaller quantities of the oil.

I have not mentioned the temperature conditions, but this is modified so as to allow the most economical consumption of re-agents.

In tests where warm liquors are used it is quite possible in

265 many cases to economize in the time of agitation, which, although in a small test is not important, would prove to be an important detail in large scale work. To conclude, the conditions of re-agents, that is to say oil, acid or acid-salts, are suitably combined with the temperature and agitation conditions so that the cost of operation would be a minimum. In all the slide-machine tests that I have conducted I have never had to use quantities of oily re-agents outside those mentioned in the Patent in Suit. The greatest amount of oil that I have ever used in practice is four pounds per ton of ore, and the smallest amount I have ever used in practice is one pound of oil per ton of ore.

52 Q. When you returned from Australia where did you find the laboratory or Works of Minerals Separation were located?

A. The Works of Minerals Separation Ltd. were located at that time at 31, Charlotte Street, London, E. C.

53 Q. Did you then remain in these London Works, and if so, for how long?

A. I remained in the London Works until in or about September, 1909, when I departed for the Caucasus Copper Company's Mine, South Russia.

54 Q. When you arrived at the Charlotte Street laboratory what apparatus did you find installed there for carrying out the agitation-froth process?

A. For small experimental tests there were one or two
266 glass gabbett or cone-mixers with the necessary spitz boxes placed in position. For the larger scale tests a plant was in position and ready for use. This was known as the Australian Model Plant. This was used to conduct tests on parcels of ore at the rate of up to three or four hundred pounds per hour. This plant was a reproduction of the flotation treatment section of the several Australian plants which I have described, but of course on a much smaller scale.

55 Q. During the period from your arrival in London until your departure for Russia, was any other testing apparatus than you have described, installed or used at the London Works of Minerals Separation, Limited?

A. Yes. A three-story plant was built to enable a re-agitation of the pulp before re-spitzing. The powdered ore was fed into a series of three agitating boxes with the usual quantities of water, oil and acid. After passing the third agitator the pulp passed directly to a spitz box that was in direct connection with the last agitator through a hole in the wall between them and which was about six or seven inches below the level of the water in the spitz box. The froth was collected and separated in the usual manner from this first spitz and the tailings passed direct to a second nest of agitators, two or three in number, the last of which was again directly connected with a spitz similar to that in the first tier. The tailings from the second spitz passed direct to another two agitators and spitz box.
267 The concentrates from the three spitz boxes were all collected on the same filter bed and the tailings from the third spitz box rejected as final residues. This type of plant was an improve-

ment in design as far as the combination of the agitators and the spitz box. This saved considerable head room. I carried out a large number of tests with this plant previous to my departure for the Caucasus.

I have omitted to describe an inclined deflecting plate placed immediately beneath the opening between the agitator and the spitz box. This deflecting plate served to direct the flow of the pulp to the surface of the spitz box and considerably calm the surface of the contained liquor. This was present in each of the three spitz boxes in use.

56 Q. When was this three-story plant erected?

A. The latter part of 1908.

57 Q. Was there any further erection or use of testing apparatus at the London Works of Minerals Separation, Limited, before you went away to South Russia, in September, 1909; if so, please describe the apparatus?

A. Yes; a similar type of plant was erected, consisting of seven agitators and three spitz boxes. The spitz boxes in this plant were all on the same level. The pulp passed through three agitators, and was delivered to the spitz box in the manner described in the last description. The tailings from this plant were pumped by an ordinary air lift or pneumatic pump to the fourth agitator. It
268 passed through agitators four and five, and from No. 5 agitator it passed to No. 2 spitz box, the same connection between the agitator and the spitz box being arranged. The tailings from No. 2 spitz box were pumped by another air lift to No. 6 agitator. It passed agitators No. 6 and No. 7 to No. 3 spitz box. The concentrates from the three spitz boxes were collected on the same filter bed. The tailings from No. 3 spitz box passed to a skin-flotation plant on the second floor, where it was divided over a nest of four square skin-flotation boxes. The tailings from these four boxes passed and were divided between two film-flotation boxes of the same nature, the tailings from these in turn passing to two more skin-flotation boxes placed immediately beneath. The tailings from these two flotation boxes passed to a filter-bed, and were considered as final residues. It was not always necessary to pass the tailings from the agitation-froth plant to the skin-flotation plant for re-treatment to recover further sulphide mineral; indeed, it was only on a few occasions that the use of the skin-flotation plant was necessary.

58 Q. What was the connection between No. 3 agitator and No. 1 spitz box, No. 5 agitator and No. 2 spitz box, and No. 7 agitator and No. 3 spitz box?

A. This connection consisted of a stout rubber pipe flanged at each end. The flanges were fastened on the inside of the agitator and the inside of the spitz box. The object of this connector
269 was to prevent any vibration being imparted to the spitz box from the agitator, so allowing the surface of the liquor in the spitz box to remain perfectly tranquil and undisturbed by the vibration from the other parts of the plant.

59 Q. When was this plant erected?

A. Just before my departure for South Russia.

60 Q. When did you return from South Russia?

A. I returned a few days before Christmas of that year, 1909.

61 Q. What large scale testing apparatus did you find installed at the London Works when you returned from South Russia?

A. This same plant was in use.

62 Q. When did you go away again, and where did you go to?

A. I departed for Emu Works, near Swansea, South Wales, and reported myself at these works on January 1st, 1910.

63 Q. What did you do at these works?

A. I was sent to assist my colleague, Mr. John Leechman, in some tests that he was carrying out to produce concentrates for the San Francisco Del Oro Mining Company.

64 Q. When you arrived at these works what apparatus did you find there for flotation treatment of ores?

A. The agitation-froth process plant installed at these works was almost identical with the plant last described, except for some
270 very slight details. One of these was that the flanged rubber pipe connecting the agitators to the frothing spitz box was fastened this time to the outside of the agitator and the inside of the spitz box. This was rendered necessary by the experience gained in working the last plant erected at Charlotte Street, where it was determined that the agitated pulp wore the inside flange of the rubber pipe connected to the agitator very rapidly, and these required frequent renewal.

65 Q. How long, or until when, did you stay at the Emu Works?

A. I remained there for a period of, roughly, three months.

66 Q. Did you receive a visit from the defendant, Mr. James M. Hyde, while you were there? If so, please relate the facts as to this visit.

A. About the end of February Mr. J. M. Hyde, the defendant, accompanied Mr. T. J. Hoover and Mr. E. H. Nutter on a visit of inspection to this plant. On the day these gentlemen arrived the plant was shut down, owing to a breakdown of the main circulating pump. They stayed over another day, and waited till the plant was restarted. This was done the next day, and normal running conditions restored. Mr. T. J. Hoover fully explained the operation of the plant and process to our visitors, and they expressed themselves as fully satisfied with what they saw.

67 Q. Did this plant operate in the production of the agitation-froth in the presence of Messrs. T. J. Hoover, Nutting and Hyde?

271 A. The plant was producing a good, thick, coherent froth, consisting of a mixed concentrate of galena and zinc blende. The thickness of the froth on the first spitz box was very rarely less than three inches, and the plant was a good demonstration of the type of work that could be accomplished by the agitation-froth process.

68 Q. What was the capacity of this plant?

A. Fifty tons per day of twenty-four hours.

69 Q. Was it operated continuously or with intermissions?

A. The running of this plant was regulated by the supply of con-

centrate required for some zinc-smelting tests that were being carried out by Messrs. Harrison & Wilding of the San Francisco Del Oro Company, and when we had produced sufficient concentrate for their need we closed down the agitation-froth plant and then started up again when more concentrates were required. This was necessary owing to lack of storage room between our filter collectors and the roasting furnace.

70 Q. On the average, what did each continuous run amount to in the tonnage of ore treated?

A. Roughly, fifteen to twenty tons.

71 Q. What usually happened when you started up the operation of this plant? Was the production of a thick froth immediate?

A. The production of thick froth usually took place about two minutes after the feed had entered the first spitz box.

272 72 Q. I call your attention to X Q. 133 and answer in the deposition of the defendant, Mr. James M. Hyde. Please state whether or not that answer is truthful.

A. The defendant is certainly mistaken. The mere fact of him suggesting that the float was very thin is in itself quite sufficient to prove that he is wrong. We would never have produced sufficient concentrate for the smelting tests if our froth had been very thin and scanty.

73 Q. How about his statement that the tailings showed the presence of a considerable amount of sulphide mineral. Is that true or not?

A. Under abnormal conditions the tailings at times did show the presence of sulphide mineral, but the usual standard of work was good and in an ore that contained a large proportion of sulphide mineral, such as this ore contained, it would require an almost complete recovery of sulphide mineral to prevent a show of the same mineral in the tailings. A hundred per cent. recovery is commercially impossible.

74 Q. I call your attention to X Q. 134 and answer in the deposition of the defendant. What have you to say as to that testimony?

A. I must call attention to the fact that the plant had been running for over two months when the defendant paid his visit to the works in the company of our general manager, and I am sure that that gentleman could not have let the opportunity go by without giving a severe official reprimand for bad work in front of

273 visitors. As neither Mr. Leechman nor myself received any letter of complaint I take it that Mr. Hoover was fully satisfied with the work that was shown to him and his visitors.

It is true that the visitors left the plant on several occasions, but this was for the purpose of inspecting the roasting, briquetting and smelting operations that were being carried on in the adjoining buildings.

75 Q. How about the statement that the attendants were constantly making changes in the hopes of achieving better results; is this true or not?

A. This is certainly untrue. The only changes that took place in the treatment of this ore was to test soap that had been forwarded

from London and I am sure that this soap was never tested in the presence of either of the three gentlemen, or at that time.

76 Q. About what tonnage of ore was treated at the Emu Works by the agitation froth process plant which you have described?

A. If my memory serves me correctly, this was slightly over two hundred tons.

77 Q. When did you return to the London Works from South Wales?

A. I returned to London shortly after Easter of that year.

78 Q. Did you see the defendant at the London Works on or after your return?

A. Mr. Hyde visited the works daily and was conducting tests on different samples of ore with the assistance of Mr. E. W.
274 Wilkinson, a recent addition to our staff.

79 Q. About how long did you remain at the London Works?

A. I remained in the London Works until the beginning of June, 1911.

80 Q. When Mr. Hyde returned from America, in December, 1910, what testing apparatus, on a large scale, was there at the London Works?

A. The works had since been removed to 2 King John's Court, where a flotation plant of the same capacity as the last unit erected at Charlotte Street was built and running almost daily. This plant was different to the unit just named inasmuch as the pneumatic pumps or air lifts had been abandoned and the means of passing the tailings from the spitz box to the next agitator was a small pipe, the agitator of the mixing vessel acting as a lift pump. The main principles of the plant remained the same. The rubber connections between the spitz box and the agitator had by this time been abandoned. The reason for this was that the structure carrying the agitator and driving shafts was of a much more substantial build and vibration was hardly noticeable. In place of the rubber pipe an ordinary hole was cut connecting the agitating box with the spitz box, and the agitator box and the spitz were directly secured together.

There was also at the back of this plant a unit erected known
275 as the "Nutter Differential Plant." The object of this plant was to take the concentrates from the Standard plant, as the first plant was then known, and to re-treat them to obtain a differential frothing flotation of the first recovered concentrate. It was also used to obtain a high recovery of sulphide mineral in the form of a poor grade concentrate, and these concentrates were to be re-treated in the Standard plant. This differential plant worked for some considerable time, but the results were not so good as they were expected to be and work on the Nutter differential plant was discontinued, after the departure of Mr. E. H. Nutter in the spring of 1911.

81 Q. I now show you British Patent No. 23,949 of 1910 to Edward H. Nutter, Theodore J. Hoover and Minerals Separation Limited, and ask you whether or not the drawing of that patent represents the Nutter "differential plant" which you have described?

A. Yes, it does.

82 Q. When you speak of a poor grade concentrate in your answer to 80 Q., just what do you mean?

A. A concentrate that could not be readily sold without retreatment to a smelter.

83 Q. What are the characteristics of such a concentrate as you just have described?

A. It would contain a very high proportion of gangue contents mixed with the valuable sulphide-mineral. This was purposely done to obtain very high recoveries in the initial treatment.

276 84 Q. Where did you go in the beginning of June, 1911?

A. I left for the Finnish-American Mining Company property, at Orijarvi, Finland, to install an agitation-froth process plant for the treatment of their various ores.

85 Q. Did you install this plant and was it successfully operated?

A. To the first part of the question my answer is yes. The plant was most successful in its operation and obtained double the recovery of the valuable metals that was being done by the existing wet-milling plant where the powdered ore was being treated over Wilfley tables.

86 Q. How long did you remain in Finland?

A. I remained in Finland nearly six months, when the Minerals Separation Ltd. recalled me to undertake some very important research work.

87 Q. What next did you do involving the erection of an agitation-froth process plant?

A. I visited the Saxbergets Mine, Rafola, Sweden, and there installed an agitation-froth process plant which was divided into two parts. The primary plant operated upon the powdered crude ore, obtaining a very high recovery of the zinc content. This concentrate was passed to a smaller re-treatment unit where the grade of concentrate was improved. From the date of introduction of the agitation-froth process the production of concentrates on this mine was

277 doubled, for the same quantity of crude ore treated. The concentrates recovered from the re-treatment plant were passed to magnetic separators where the worthless magnetic pyrites were removed. The concentrates from the magnetic separator were then passed to Wilfley and Krupp-Ferraris tables, to separate the mixed concentrate into the more saleable lead and zinc products. This series of re-treatments were conducted on the concentrates without any special preparation. The small quantity of oil on these concentrates rendered this unnecessary. When I left Sweden this plant was giving a recovery of over 90 per cent. zinc. This good work is still being maintained.

88 Q. Please give the period of time when you were in Sweden in connection with the plant just described?

A. Seven or eight weeks. I was then recalled to England by my firm to undertake other important work.

89 Q. From about what date to about what date?

A. From early June to late July, 1912.

90 Q. What plant was replaced, if any, by the agitation-froth

process plant installed at the Saxbergets Mine in Sweden as you have just described?

A. The plant before the erection of the agitation-froth process plant consisted of ordinary wet concentrators, consisting of tables and buddles.

Adjournment till Monday the 26th of August, 1912, at 10:30 A. M., at the same place.

278 London, August 26, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination of Mr. Chapman continued:

91 Q. Was there any other ore-flotation plant at the Saxbergets Mine, Sweden, while you were there? If so, what was it and was it, or was it not, in use?

A. Yes, there was an Elmore vacuum-plant consisting of two units; the use of this plant had been discontinued and the old method of water concentration reverted to some time before my arrival in Sweden.

92 Q. In the work done by you in Broken Hill on the several commercial plants which you have described for carrying on the agitation-froth process, what oil was used and in what proportions?

A. We used oleic acid at the rate of about one and a half pounds per long ton of ore.

93 Q. The tons of ore that you have referred to in your testimony are all long tons, are they not, of 2,240 pounds?

A. Yes.

94 Q. I will therefore assume that you mean a long ton unless you state to the contrary. Did you at any time in any of the Broken Hill commercial agitation-froth plants use any other oil than oleic acid? If so, please state under what circumstances, for how long and in what manner?

279 A. We changed the type of oil being used on two occasions only. These were to test special samples of fish oil and a soap known as Karsam soap, which is a petroleum soap. These samples were placed in small kerosene tins with taps for adjustment of the flow of oil or soap being tested. Without changing the feed conditions of ore and water the oleic acid feed to the plant was cut off and the tap opened of the tin containing sample to be tested. In the case of the Karsam soap the test lasted about four hours. This four hours was sufficient time for us to take running samples of the product and for us to gain all the information we wanted in reference to consumption of re-agent and recovery of the valuable mineral constituents. Normal running conditions of the plant were then restored. In the case of the fish oil the test did not last more than half an hour. The men working the plant with this oil were seized with violent sickness and we had to discontinue

the use of this oil, and for this reason we did not pursue the matter any further.

95 Q. What was the acid consumption at these Broken Hill commercial agitation-froth plants?

A. This varied from fifteen to twenty pounds per ton of ore.

96 Q. Now as to the agitation-froth plant at the Emu Works in South Wales, what oil was used and what amount per ton of ore?

A. We used oleic acid, amylacetate and on occasions Karsam soap. The consumption of oleic acid was, roughly, two pounds per ton. The soap, when being used with the oleic acid, about .2
280 pounds per ton. Amylacetate, when being used with oleic acid, from .25 pounds per ton up to .5 pounds per ton. Amylacetate, when being used alone in the first test, about one pound per ton.

97 Q. For what part of the time during this few months' run did you use amylacetate alone?

A. For only about two days after my arrival.

98 Q. What was the acid consumption at the Emu plant referred to in your testimony?

A. The actual acid consumption varied between 60 to 70 pounds per ton of ore.

99 Q. With this acid consumption, did you have acidified liquor in your spitzkasten?

A. No free acid could be determined by means of ordinary testing.

100 Q. In what manner did you add this acid?

A. This acid feed was added in small portions throughout the agitation stage of the process. The acid was divided into mixers or agitators No. 1, No. 3, No. 5 and 7. The object of this divided addition of acid was to economize the total acid consumption as far as possible. So that this may be fully understood, I should mention that the theoretical acid consumption, that is, the acid required to neutralize the calcite in the ore and obtain an acidified solution, exceeded one hundred pounds per ton.

101 Q. What was the result in this instance of using this quantity of sulphuric acid less than what was necessary for decom-
281 posing the calcite and producing an acidified liquor or solution?

A. We were enabled to produce a high grade concentrate at the expense of a reduction in recovery. This was the condition we were aiming for. The plant was never run for recovery, but only for the production of concentrates to test by the Picard briquetting-smelting process. The San Francisco Del Oro Company had been fully informed of the recovery and conditions of treatment by the results of official trials that had taken place in London some time previously. They had all the recovery factors and they were chiefly concerned in carrying out smelting tests on the concentrates to determine whether the presence of fluorspar in these concentrates detrimentally affected the life of the zinc retorts used in the briquetting process.

102 Q. Now as to the plant installed by you in Finland, what oil was used and in what amount per ton of ore?

A. We used oleic acid and eucalyptus oil. The two oils were added at the following rates: Oleic acid from .5 to two pounds per ton; eucalyptus oil, .2 pounds per ton.

103 Q. And what was the acid consumption per ton of ore?

A. The acid consumption in this plant was between 16 to 20 pounds per ton.

104 Q. Now as to the plant installed by you at the Saxbergets Mine in Sweden, what oil was used and in what amount per ton of ore?

282 A. We used a very cheap locally obtained wood tar oil. We used four pounds per ton of ore treated.

105 Q. And what was the acid consumption per ton of ore?

A. The acid consumption was only five or six pounds per ton.

106 Q. I take it that when you have referred to acid in your previous testimony you have referred to sulphuric acid?

A. I have referred to commercial sulphuric acid.

107 Q. What was the capacity of the Finland plant installed by you?

A. Fifty to seventy-five tons per day of twenty-four hours.

108 Q. What was the capacity of the Saxbergets plant in Sweden installed by you?

A. The primary treatment plant had a capacity of one hundred to one hundred and fifty tons per day. The re-treatment plant for the re-treatment of concentrates had a capacity of fifty to seventy-five tons per day of twenty-four hours. By day I always mean twenty-four hours.

109 Q. About what relation have you found to exist between tests in the slide machine and the actual working of commercial plants, when the agitation-froth process is tested and used?

A. The results produced by the agitation-froth process in practice have been, on every occasion that has come under my own personal observation, an improvement on the result obtained in the

283 slide machine. The improvements were not only those of recovery, but in the consumption of re-agents.

110 Q. What has been your experience when, in using the agitation-froth process on a commercial scale, with a normal and proper consumption of one and a half pounds of oil per ton of ore, this procedure has been varied by increasing the oil feed to two and a half pounds per ton of ore?

A. The mineral froth being produced on the spitz boxes loses at once some of its natural color and lustre and becomes dull in appearance. The quantity of froth being recovered on No. 1 box is considerably lessened. The froth on No. 2 spitz is slightly increased and the same with No. 3 box. The tailings on examination immediately show increased losses of sulphide mineral. These losses take the form of well oiled agglomerations.

111 Q. And what has been your experience when the normal and proper feed of one and a half pounds of oil per ton of ore has been diminished to half a pound of oil per ton of ore?

A. The froth being recovered immediately diminishes in quantity and the colour shows the presence of slime gangue. The sup-

porting liquor of the spitz box immediately changes in appearance and shows the natural colour of the ore slimes. The tailings become very dirty and show no sign of what we know as a good "clean-up." In fact the whole treatment suffers and unless the oil feed is restored to its normal condition a serious drop in recovery takes
284 place with the production of a lower grade concentrate.

112 Q. Please state what, if anything, you did in testing the ore of the Braden Mine in Chili?

A. I carried out a large number of tests on this ore chiefly confining myself to determine the extent to which the ore had to be powdered before treatment. I determined that this ore had to be crushed to 80 mesh (Institute of Mining and Metallurgy Standard Screens). The treatment of the ore was simple and was carried out at ordinary atmospheric temperature conditions. The acid consumption was five to six pounds per ton. The oil consumption was three pounds of Texas fuel oil and about one pound of American wood-tar oil per ton of ore. We obtained recoveries of eighty-five to ninety per cent. of the copper content in a concentrate assaying ten to fifteen per cent. of copper, the original content being roughly three per cent. of copper. These results have been considerably improved in practice, and the installation of a very large plant at present, one thousand two hundred tons per day, is now taking place as a result of the trials carried out in a two hundred and fifty ton per day testing unit.

113 Q. I now show you British Patent 17328 of 1906. Are you the communicator named in this patent?

By Mr. Scott: Objected to as irrelevant and immaterial.

A. I am.

114 Q. Where were you when you made this invention, and how in general was it used?

285 By Mr. Scott: Objection repeated, and it is stipulated that it may stand to all questions in relation to this patent and invention.

A. I was in Broken Hill, New South Wales, Australia. The method afterwards became the general practice of my Company.

115 Q. What is the practice in Australia in handling the water used with the mineral to form the pulp?

A. Owing to the high cost of water this circuit was a closed circuit and the water from the product was returned for use.

116 Q. Did you find any beneficial advantage from thus returning the water and using it over and over again, and if so, what?

A. Yes. After the ore had been powdered suitable for feeding to the agitation-froth process a quantity of water had to be extracted from the pulp to enable us to feed the pulp in correct and economical condition for the agitation stage of the process. To do this we employed a pulp thickener or de-waterer. The effect of the acid salts and traces of free acid that may have been in solution was to cause a very quick settlement of the slime gangue with the grainy portion

of the powdered ore. This enabled us to economize in settling space and largely assisted us in the saving of room.

117 Q. And what acid do you refer to in your last answer?

286 A. Sulphuric acid.

118 Q. Was there any re-treatment of concentrates in your work in Australia with the agitation-froth process? If so, please relate the particulars thereof?

A. In No. 1 flotation plant the first shift of every week re-treated and added with the crude feed about thirty tons of poor grade concentrate that had been collected in the sump. In the Minerals Separation Tailings Plant the re-treatment of concentrates was practically continuous. The overflow from the concentrates draining belt passed to suitable collecting launders where the settlement of any lost concentrates took place. This was regularly fed by a boy to the treatment section as it was produced.

119 Q. You say in your last answer that the poor grade concentrates were re-treated and added with the crude feed, which occurred first, the addition to the crude feed of the poor grade concentrates or the retreatment of these poor grade concentrates?

A. The addition to the crude feed of the poor grade concentrates.

120 Q. I now show you a drawing. Please state what it represents?

A. This represents the plant installed at the Emu Works, South Wales, and the last plant erected at the Works of Minerals Separation Limited at Charlotte Street, London, E. C.

121 Q. Please briefly describe this drawing with reference to the lettering thereon.

287 A. A are the mixers, B are the spitz boxes, C are the air lifts or pneumatic pumps which deliver the tailings for the next step in the treatment, D are the air feed pipes, E are the rubber flanged connectors connecting the agitator to the spitz boxes.

By Mr. Williams: The drawing referred to by the witness, the same being on two separate sheets marked Sheet 1 and Sheet 2, is offered in evidence and marked "Complainants' Exhibit, Drawing of 1909 and 1910 Agitation-froth plants."

122 Q. You have referred in your testimony to tests made by you of the Elmore bulk-oil process. What proportion of oil did you use relatively to the ore in these tests?

A. This varied according to the ore being tested. I used as a minimum equal weights of oil and ore and as a maximum the oil three times the weight of the ore.

123 Q. In this Elmore bulk-oil process, was there any aeration of the float?

A. We did everything we possibly could to make the mixture of the ore pulp and oil to be of a most gentle type and it was our aim to avoid any breaking up of the oil. No aeration took place.

Direct examination closed.

Cross-examination.

By Mr. Scott:

124 X Q. What was the nature of your experiments in connection with the Elmore process?

288 A. Under the instructions of Messrs. Sulman & Picard I carried out tipping tests on various samples of ore, in a glass cylinder.

125 X Q. Will you explain a little more in detail the nature of these tipping tests?

A. I took a glass cylinder that would hold 1200 cc. of water and in this placed 100 grammes of crushed ore. To the ore would be added 600 to 800 cc. of water. Upon this would be placed 100 grammes of thick residuum oil. The stopper would be placed in the cylinder and the cylinder was then gently tipped or revolved in a vertical direction. I would exercise great care not to break up the oil which would bring about a frog's spawn effect. After about thirty tips, that is to say, fifteen vertical revolutions of the cylinder, I would let the water pulp settle. I would then draw off the oil by means of a spatula and transfer this to a basin. An examination of the tailings would show whether a good recovery of the sulphide content had been obtained. If this showed the presence of sulphide mineral I added a further hundred grammes of oil and resumed the tipping. After another thirty tips I would stop the test and draw the oil off as before. If necessary this would be carried out three times. The oil would then be thinned down by means of a thinner oil such as paraffine or benzine and the concentrate collected on a filter. These were weighed and sampled for assay. From the assay and weight of the crude ore and the weight and assay of the recovered concentrates the recoveries could be calculated.

289 126 X Q. Can you remember approximately what degree of recovery and what purity of concentrates you secured by this method?

A. The recovery varied according to the ore being treated. I have on occasions obtained eighty per cent. recovery and of a concentrate carrying ten to fifteen per cent. of gangue. This result was not always obtained. With a good clean sulphide ore with a silicious gangue I could obtain the former result. But it was very rarely that this high standard of work (by high standard I mean the standard set by the Elmore bulk flotation method) was attained.

127 X Q. Did you use acid in these Elmore experiments?

A. These Elmore experiments were carried out to investigate two processes owned by the Elmore Company. One was the treatment without acid, and this was followed some little time later by one in which acid was used. In the original Elmore process no mention is made of the use of acid.

128 X Q. You tried your experiments, then, both with and without acid?

A. Yes.

129 X Q. Did you experiment with the Elmore process in any other apparatus than the cylinder you have mentioned?

A. Yes, I experimented with a section of the Elmore cylinder.

130 X Q. This was a cylinder containing a sort of a spiral baffle in its interior and with open ends?

290 A. This section was a complete spiral, or one complete revolution of the spiral.

131 X Q. Will you describe this Robson and Crowder oil-washing process briefly?

A. This process consists of mixing powdered ore with about thirty per cent. of its weight in water. After thoroughly wetting the ore a light oil is washed through the mass, the intention being for the oil to wash out the sulphide mineral and allow the tailings to remain. This process required an enormous bulk of oil compared with the bulk of ore being treated. The valuable constituents are recovered by an oil-wash and not by an oil-float.

132 X Q. In experimenting with the Cattermole granulation process was any of the metalliferous mineral floated instead of being precipitated?

A. The tailings from the Cattermole process if they contained mineral were placed over tables to recover this by skin flotation or the oiled needle effect.

133 X Q. Did you ever try an experiment in which you suspended suitably crushed ore in water, added an amount of oil insufficient to float the metalliferous mineral, then generated a gas in the mixture by means of sulphuric acid and calcite, performing these operations for the purpose of floating the metalliferous mineral by means of films or bubbles of gas so generated?

A. No.

134 X Q. Will you describe the Wolf or Scammel process with which you experimented?

291 A. The Wolf or Scammel process is an improvement on the Elmore bulk oil flotation process. It consists of submitting the oil to be used to a treatment with sulphur-chloride. This oil had the effect of remaining in an unbroken condition more perfectly than the Elmore untreated oil. The tests were carried out in the same manner as those described in the previous answer referring to the Elmore bulk-oil process.

135 X Q. Will you describe the apparatus sent by Mr. Froment to London with which you experimented?

A. This consisted, firstly, of a mixing vessel standing on three or four legs. The agitator consisted of wire beaters revolved by means of a handle suitably geared to the spindle carrying the beaters. Secondly, the separating pan consisted of a cylindrical vessel in which two lead coils were laid side by side on the bottom. Above this was a scraper intended to impart a slight disturbance to the ore in the separating pan. One of these coils could be used for the feeding of acidulated water. Usually sulphuric acid was used. The other coil I never had occasion to use, but I was given to understand that this was to keep the oil in a fluid condition by means of steam passing through the coil. The third portion of the apparatus, which I never used, consisted of a screen on which it was intended to collect

the oily flocks of mineral left in the tailings and would allow the tailings to pass through the screen.

136 X Q. Did you ever see any steam connection made to the coil in the second element of the Froment apparatus?

292 A. No.

137 X Q. You have referred to a small glass apparatus of the type shown in Figure 1 of the drawings of Patent 793,808 and have said that tailings from the Cattermole process containing sunken flocks of mineral were placed in the apparatus and air pumped into the perforated spiral which was rotated slowly. Why do you refer to these as "sunken flocks?"

A. These flocks of mineral or imperfectly formed granules passed over with the upcast water from the up-cast classifier. These sank to the bottom of the collecting vessel with the rest of the tailings.

138 X Q. Did you ever make any tests of the operations set forth in the Patent in Suit by performing those operations in a bottle or test tube?

A. Yes.

139 X Q. Will you describe how you did it?

A. I would take a bottle of a capacity of, say roughly, 100 cc. and in it place 20 grammes of ore and 70 grammes of water. To this I would add sulphuric acid to equal roughly twenty pounds of acid to the ton of ore. To this I would then add oil by drops equivalent to one and a half to two pounds of oil per ton of ore, and agitate vigorously. These tests would serve as an indication only, and would be used to indicate the condition for the first investigations when using the Sulman & Picard slide machine. I would never use a bottle test to obtain quantified results and would only use it for the reason I have just mentioned.

293 140 X Q. Did you ever try the Froment process using a test tube or bottle?

A. I have tried the Froment process in a test tube and the results were of a most unsatisfactory nature and dangerous to the operator. On the final addition of acid to the calcite the whole contents of the test tube would spurt up and great care had to be exercised to prevent any of this material getting into the eyes.

141 X Q. Please explain exactly how you proceeded in trying the Froment process in a test tube?

A. In using a test tube of course the quantities used are so small that it would be a most difficult matter to quantify the oil to the ore. This was done as nearly as possible, namely, in the proportions mentioned in my direct examination. This was vigorously agitated until I had satisfied myself that the oil coating of the mineral had been completed. I would then add the acid with the result stated above.

142 X Q. Did you ever try the Froment process by placing the ore in a test tube, adding limestone, water, acid and oil and then agitating the test tube for a brief time?

A. I have set out to do this but have never succeeded, for a violent evolution of CO_2 took place before the oil could be added.

143 X Q. How many times did you try to do this?

A. I tried this three or four times and I found the operation quite dangerous and discontinued attempting.

144 X Q. Did you ever see anyone else perform this experiment in this way?

294 A. No.

145 X Q. You consider that it would require someone of peculiar skill to perform the experiment in that way?

A. Skill hardly comes into the matter at all in this test. I took the best precautions I could to preserve my eyesight.

146 X Q. You consider it a practical impossibility to carry out this experiment in this way?

A. You could never complete the test because you would lose half of your pulp before you made your oil addition.

147 X Q. Did you ever see the Froment Patent at the time that you were experimenting?

A. I cannot answer this to any degree of certainty, but the Patent and apparatus were fully explained to me by Mr. Sulman.

148 X Q. You are not sure then when you were experimenting to ascertain whether the process of the Froment patent could be carried out, that you had ever seen the Froment Patent?

A. No, I am not sure. I was working entirely under the directions of Mr. Sulman who carefully watched my work.

149 X Q. Were you shown any instructions which were sent by Mr. Froment to Minerals Separation Ltd., that is, were you shown them at the time you were experimenting with the Froment process?

A. I was not shown these instructions, but these conveyed verbally to me by Mr. Sulman.

295 150 X Q. When you experimented with the apparatus which Mr. Froment sent to Minerals Separation Ltd. how rapidly were the beaters revolved in the agitator?

A. This portion of the apparatus was worked by hand, and naturally the agitation could not be of a violent type. The agitation continued until it was seen that the sulphide mineral was coated with oil.

151 X Q. Did you take any steps to produce such a speed of rotation of the Froment gears as was recommended by Froment in his instructions, or did you know what his instructions were as to the speed of rotation of the beaters?

A. The object of the agitation was to oil-coat the mineral and the agitation was lengthened accordingly. I had no definite instructions as to the speed of the beaters but the object of them was fully explained inasmuch as the sulphide mineral had to be oil-coated.

152 X Q. How did you ascertain when the sulphides were coated with oil?

A. I would take a small portion of the pulp from the mixer and examine it on a plaque. The oiling of the mineral would be apparent at once.

153 X Q. In what way does the oiling make itself apparent?

A. The mineral would collect in flocks, lose its natural color and lustre and be quite oily to the touch.

154 X Q. Did you ever try the Froment process with oil amounting by weight to one per cent. of the ore being treated?

296 A. The quantities of oil I used in the Froment test were always between 60 and 120 pounds per ton which equals roughly from 3 to 6 per cent. of the weight of ore.

155 X Q. Did Mr. Sulman instruct you to use these amounts of oil?

A. I was working entirely under Mr. Sulman's instructions.

156 X Q. Did Mr. Sulman ever instruct you to try the Froment process with an amount of oil that would just produce a film upon the sulphide particles?

A. No.

157 X Q. What kinds of oil did you use in experimenting with the Froment process?

A. We used the same oils in the Froment process as we did in our work on the Cattermole process.

158 X Q. Have you any idea how fast you rotated the beaters in the Froment machine?

A. I have no idea of the speed of the beaters, but the handle was turned from thirty to thirty-five revolutions per minute.

159 X Q. Why did you substitute the gabbett for Froment's agitating apparatus in your later experiments?

A. These gabbetts were mechanically driven and I could treat smaller parcels of ore per test.

160 X Q. Were all your experiments with the Froment process tried upon Broken Hill ore?

A. They were all conducted on Broken Hill crude ore.

297 161 X Q. About how much carbonate did that ore contain?

A. The ore actually contained under one per cent. of carbonate but we added ten per cent. of crushed calcite to the ore.

162 X Q. In all of your experiments did you add ten per cent. calcite to the ore?

A. Yes. When testing the Froment process.

163 X Q. You never varied this amount then for the purpose of reducing the generation of carbon dioxide?

A. No, but the method of mixing the calcite to the ore was done in two ways. First, the calcite was added to the ore before treatment, and secondly, the calcite was added to the settled paste, the production of which I described in my direct examination.

164 X Q. What became of the 60 or 70 pounds of acid per ton of ore which you used at the Emu plant, leaving as you say, no free acid in the spitzkasten?

A. This was immediately consumed by the calcite in the agitating vessels.

165 X Q. How much carbon dioxide would be generated by 70 pounds of sulphuric acid acting upon calcite?

A. 31 pounds.

166 X Q. About what percentage of pure sulphuric acid was contained in the acid used at Emu?

A. This varied between 72 to 80 per cent. mono-acid.

167 X Q. Please explain, in order to make the record clear, what you mean by mono-acid?

298 A. Mono-acid is theoretical one hundred per cent. acid, and in careful calibration of acid consumption, where the quality of the acid varies, the only comparison can be made by using such a standard.

167½ X Q. When you stated that the acid consumption at Emu varied from 60 to 70 pounds per ton of ore, did the figures 60 to 70 represent pounds of commercial impure acid or mono-acid?

A. Commercial acid.

168 X Q. And how much of pure or mono-acid would this represent?

A. Using 60 pounds of commercial acid per ton, this represents from 43.2 to 48 pounds of one hundred per cent. acid per ton. Using 70 pounds of commercial acid per ton, this means 50.4 to 56 pounds of one hundred per cent. acid per ton.

169 X Q. What amount of carbon dioxide would be generated by a complete reaction between 43 pounds of pure sulphuric acid and calcite or calcium carbinate?

A. 19 pounds.

170 X Q. And what amount of carbon dioxide would be generated by 56 pounds of pure sulphuric acid?

A. About 25 pounds.

171 X Q. About what was the temperature of the pulp in your operations at Emu?

A. 65 to 70° Centigrade.

172 X Q. At 65° Centigrade can you state what the volume would be of 19 and 25 pounds respectively of carbon dioxide gas under normal atmospheric pressure?

299 A. Taking 11 cubic feet of CO_2 to weigh one pound at that temperature, 209 cubic feet to 275 cubic feet.

173 X Q. And this 209 to 275 cubic feet of carbon dioxide gas was generated in the mixers at the Emu plant each time a ton of ore passed through the mixers, was it not?

A. Yes.

174 X Q. In experimenting with the apparatus of the type shown in Figure 1 of the drawings of Patent No. 793,808, for the purpose of investigating the Sulman and Picard bubble process, you have referred to operating upon tailings from the Cattermole process. Did you ever operate upon crude ore with this apparatus?

A. No. My investigations were only in regard to the "clean up" of Cattermole sands.

175 X Q. Then, I take it that you never used this apparatus for the purpose of so agitating the pulp as to bring the oil into contact with the ore?

A. The apparatus being made of glass, it would have been impossible to violently rotate the worm without breaking the apparatus, and it should be undertood that the mineral in these Cattermole tailings had already been oiled in the previous operation. The oil was already in contact with the sulphide mineral, and I had no occasion to use the apparatus as an agitator.

176 X Q. Did you ever see any apparatus of the type shown in Figure 1 of the drawings of Patent 793,808 other than the glass structure to which you have referred?

300 A. That is the only one I have seen.

177 X Q. Did you see any other Froment apparatus besides that which you have referred to in connection with your experiments?

A. The only Froment process I have seen other than those I have referred to in my experiments has been the application of this glass apparatus that we have just been discussing in the application of the Froment method.

178 X Q. In about what proportions was the total amount of acid used at Emu divided up between the different points at which it was added? I believe you stated that the acid was added in the first, third, fifth and seventh mixers or agitators.

A. In No. 1 agitator about fifteen pounds of commercial sulphuric acid per ton of ore; in No. 3 twenty-five pounds commercial acid per ton of ore; in No. 5 fifteen pounds commercial acid per ton of ore, and in the last mixer ten pounds.

179 X Q. About what is the range of the percentage of carbonate present in ores which you have successfully treated by the operation conducted by Minerals Separation, Limited?

A. In no case have I had samples that have been returned as giving more than .2 per cent CO_2, except in the case of the San Francisco del Oro ore, where the calcite was about 5 per cent. of the total ore. In the Finnish-American and Saxbergets ore only traces of calcite existed, and no assay returns of CO_2 could be made on these samples.

301 180 X Q. In your operations in Australia did the pulp in the spitkasten show an acid re-action?

A. In running these plants it was intended that the pulp in the spitz boxes should show no free acid, but, of course, at times of careless working, this may have occasionally been the case; but the flotation operator was distinctly told to have no free acid in the spitz box liquor.

181 X Q. Was there any odor of hydrogen sulphide noticeable in the operation of the Australian plants which you saw or operated yourself?

A. The only instance I met with was in the period of starting up the Zinc Section of the New Mill. Here the condition disappeared in a few days. I might point out that at this time they were overcoming underground difficulties and recovering their gangways, and restoring everything to a normal condition after the disastrous creep that occurred a few months previously. Under these conditions we did not receive ore that was representative of the mine. The material we were getting was very patchy, and no doubt, if the ore from this part of the mine had been mixed in the correct proportion that it there exists, the smell of H_2S would never have been perceptible. When full normal mine and mill conditions were restored this smell of H_2S was never noticed.

182 X Q. Was the odor of hydrogen sulphide noticeable in the

operation of any of the plants you have referred to other than those in Australia?

302 A. No.

183 X Q. Did the generation of hydrogen sulphide in the instance you have referred to, at the Zinc Section of the New Mill, interfere at all with the efficient operation of the process ?

A. This point was never definitely settled. When the smell of H_2S disappeared the investigation on this subject was dropped.

184 X Q. You have no reason to believe, have you, that the evolution of hydrogen-sulphide caused any particular effect advantageous or disadvantageous?

A. We were never given the opportunity to fully prove or disprove this, as the plant was operating under conditions that were abnormal in many respects.

185 X Q. What is the advantage in using acid-salts instead of free acid in those cases where calcite is present in what you have referred to as disturbing quantities?

A. It allows an economy in the cost and consumption of that reagent.

186 X Q. Does the acid salt react with the carbonate?

A. Yes.

187 X Q. But the acid salt is cheaper than the free acid?

A. Yes.

188 X Q. Taking the Emu plant as an illustration, what is the purpose of having several agitators in series through which the pulp passes before going to the first spitzkast, and having a similar

303 arrangement of a plurality of agitators through which the pulp runs before reaching the second and third spitzkasten? Is this merely to permit the pulp to flow more rapidly and still give it the same period of agitation as it would have if passed more slowly through a single agitator?

A. The same effect would be produced in one agitator, provided the pulp received the same amount of agitation as it receives in going through the three agitators. The later agitators are merely for the retreatment of the first residues, and to give any potential froth that escaped the first spitz box an opportunity by re-agitation of becoming a real froth that could be readily separated in the later spitz boxes.

189 X Q. Referring then to the first group of three agitators in the Emu plant, the pulp can flow through at approximately three times the velocity that could be given it if only one agitator were employed, presuming that the time of agitation necessary has been determined and must be prolonged for at least that amount of time? In other words, it would make no difference, would it, whether the pulp were agitated three minutes in one agitator or one minute in each of three agitators through which it successively flows without pause?

A. I should think the effect would be the same provided that all other conditions, that is to say, height of liquor in the agitator, pulp thickness, oil and acid, were the same.

190 X Q. While in Australia, did you witness the operation

304 of other flotation processes than the one operated by Minerals Separation Limited?

A. The only plant that I was allowed to enter was the Gillies Sulphide Treatment Company's plant, situated on the Block 10 property, and then I inspected this plant on receipt of instructions from Mr. C. F. Courtney, who asked me to report on the possibility of adapting this process to our method. The process being operated was the Potter process modified, a Gillies separating pan being used for the application of this flotation process. I was never allowed to enter the plants operating in other parts of Broken Hill, although on several occasions I applied for permission.

191 X Q. What were these other plants which were operating to which you did not gain admittance?

A. The De Bavay Company, the Block 14 Potter process plant, the Elmore Vacuum Plant, situated at the Australian Metal Company's Works, and also the Elmore Vacuum plant, situated on the Zinc Corporation property, South Broken Hill. I did attempt to visit the Delprat plant on the Proprietary Mine as an ordinary visitor, but my effort was fruitless. I could not gain admission when they identified me.

192 X Q. Were these other plants which you have referred to in practical operation at the time you were in Australia?

A The Block 14 Potter Process Plant was in operation at the time I was carrying out the tests for our clients, the Sulphide Corporation Limited, on the occasion of my first visit to Australia. I can-
305 not say definitely whether the Delprat process was working at that time. Neither of the Elmore plants referred to in my last answer were running until we were carrying out the large trial for the Zinc Corporation Limited. At that time the one unit Elmore testing plant, situated at the Australian Metal Company's Works, was conducting trials on the Zinc Corporation material. The Elmore plant at South Broken Hill did not commence operations until some months after the agitation-froth process was abandoned by the Zinc Corporation. The De Bavay process was working at this period on the plain water flotation. I understand that this treatment was modified later, but I did not see the process at any time. The Gillies plant started operations some considerable time after the agitation-froth process was an established success. The Delprat plant on the Proprietary Mine was operating about the same time as the agitation-froth process was getting into full swing.

193 X Q. In connection with the plant built at the testing laboratory of Minerals Separation Ltd. in London, just before you left for Russia in September, 1909, I would like to have you describe the skin-flotation plant mentioned by you, doing so a little more in detail than you did in your previous reference to that apparatus.

A. This portion of the plant consisted of four square skin-flotation boxes placed on the same level. Immediately beneath these two more skin-flotation boxes were placed so that the pulp tailings from
306 the first nest could be passed directly and divided over two more skin-flotation boxes, and beneath these again two more boxes were placed. In feeding the pulp over these boxes the material was allowed to meet the water very gently, and to do this a pyramid was placed in the center of each box with its base three inches below

the level of the liquor, and the point of entry to the water surface about three inches from the overflow. These boxes were arranged so that the overflow took place on the four sides. The reason for this was that the capacity of skin-flotation boxes is exceedingly small when the ordinary one-lip overflow method is employed, and it is obvious that to obtain the best result the four-sided overflow box would have a capacity four times that of the single overflow box. The method of dividing the feed over the top four boxes was to employ a slowly revolving pipe which delivered and divided the pulp into four separate launders.

Adjourned to Tuesday, August 27th, 1912, at 10:30, at the same place.

London, August 27th, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Mr. Chapman continued:

194 X Q. What is the weight of a cubic foot of water?
307 A. 62½ pounds.

195 X Q. And taking eleven cubic feet of carbon dioxide gas to weigh one pound, one cubic foot of that gas would weigh how much?

A. 0.091 of a pound.

196 X Q. Then, if a cubic foot of carbon dioxide gas were to be submerged in water, what would be its buoyant effect in pounds?

A. Roughly, 62.4 pounds.

197 X Q. And the entire buoyant effect of the 275 cubic feet of carbon dioxide gas generated by the use of the maximum amount of sulphuric acid used at Emu would be 275 times 62.4 pounds would it not?

A. Yes, providing the buoyant effect of this volume of gas was applied at one time and on the same mass.

198 X Q. And in the operation of the plant at Emu I presume this carbon dioxide was generated gradually and practically continuously throughout the mixers or agitators by reason of the addition of the sulphuric acid in installments, part in each of the first, third, fifth and seventh agitators?

A. The condition of generation of CO_2 in the Emu plant could not under any circumstances be considered as gradual. The production of CO_2 under the conditions of temperature, acid, violent agitation, is immediate, and is of the type which I described to you in carrying out the attempted Froment test-tube test. The evolution of CO_2 took place immediately the calcite came in contact
308 with the acid solution, and therefore the production of CO_2 would only be sustained as long as the free acid remained and therefore the production would not be continuous.

199 X Q. I presume one of the purposes in adding the sulphuric acid in four installments was to spread out the evolution of CO_2

through the entire process rather than to concentrate it at one point. Is that correct?

A. The production of CO_2 never entered into our calculations at any time beyond the fact that we realized that under such conditions a large consumption of sulphuric acid resulted. The object of the acid being added at these various stages was as follows: The acid in No. 1 mixer was to allow the oil to select the sulphide mineral without allowing oil contact to the calcite. The addition of acid to No. 3 was to cut out any gangue from the concentrate and allowing it to be thoroughly wetted so that it would remain with the residues. The acid addition in mixers No. 5 and 7 was for this reason only. It was never our intention to make use of the CO_2 produced for flotation purposes, for we realized that under the conditions of agitation, high temperature, acidulated solution, the enormous volumes of air beating in and out of the pulp were quite sufficient to cause the almost complete loss of CO_2 in the agitators and I can conceive no condition that would allow anything but an accidental small proportion of the gas produced in the agitators passing out with the pulp to
309 the spitz box. If we wished to take advantage of this gas production for flotation purposes the most obvious thing would have been to add the acid in the spitz boxes where the nascent gas would then be liberated. As a matter of fact in the instance of the Emu plant this production of CO_2 per mixer, per minute, was only 0.6 cubic feet, and this quantity is exceedingly small when compared with the enormous quantity of air that would be beaten in by the very violent agitation.

200 X Q. You arrive at this rate of production of carbonic acid gas I assume by dividing the total amount, 275 cubic feet, evolved per ton of ore, by the number of minutes occupied by a ton of ore in passing through the mixers. Is that correct?

A. I have taken the rate of feed to be one ton an hour which was the average rate of feed at this plant. Therefore I have divided 275 cubic feet by 60 (minutes) multiplied by 7 mixers.

201 X Q. According to this method of calculation then, in all seven mixers taken together, four and two-tenths cubic feet of carbon dioxide would be generated each minute. Is that right?

A. That is so.

202 X Q. And the ratio of the volume of carbon dioxide gas generated per minute to the ore passing through the plant would be the same, would it not, whether the ore passed through at the rate of a ton per hour or ten tons per hour?

310 A. I cannot agree with you here. It is a well known fact in the operation of our processes that the bigger the tonnage operated upon the more easy it is to effect economy of reagents. This is more particularly applied to sulphuric acid for I have known instances that have come directly under my own personal observation where the tonnage being treated has been doubled and the acid feed has remained unaltered in total quantity, and therefore per ton of ore the acid feed has been reduced by fifty per cent. This alteration of the acid feed being possible you can understand that no parallel

can be drawn between the conditions of one ton an hour and ten tons an hour.

203 X Q. You did not operate the Emu plant at its full capacity then, when running through only one ton an hour?

A. The tonnage being treated in this plant was regulated by the capacity of the one grinding pan that we had installed, and it was our constant endeavor to increase this tonnage.

204 X Q. In the operation of the Emu plant did the 275 cubic feet of carbon dioxide that was evolved per ton of ore contribute materially to the production of the froth?

A. I consider that practically no production of froth resulted from the evolution of CO_2.

205 X Q. In other words you mean that under these conditions where 275 cubic feet of carbon dioxide were evolved per ton of ore, that still the production of the froth resulted from the air
311 introduced during the agitation which was necessary to mix the oil with the mineral rather than from the carbon dioxide so evolved?

A. I consider that the beating in of air had many hundred times the influence in the assistance of froth production than that of the CO_2.

206 X Q. Did you ever make any determinations of the gases contained in the froth produced by the Emu plant?

A. No, I did not. My time was fully occupied in the production of concentrates. In any case I was quite satisfied that the CO_2 played no important part in froth production.

207 X Q. This conclusion, so far as the Emu plant is concerned, is based upon your theoretical reasoning, is it not?

A. In coming to the conclusion that I did I combined common sense with theoretical reasoning, and I had only to look into one of our agitators to realize the enormous volumes of air that were being beaten into the pulp, compared with the comparatively small proportion of CO_2 being evolved, and I understood how impossible it is for any large amount of CO_2 gas to remain in solution under these conditions of acidulated liquor, high temperature and violent agitation.

208 X Q. Is it your understanding that a considerable proportion of the carbon dioxide goes into solution?

A. My correct understanding should have been described as being held in suspension.

312 209 X Q. Would the temperature at which you worked, 65° Centigrade, have any greater tendency to exclude carbon dioxide from the water than it would to exclude air?

A. It is quite possible under these conditions of violent agitation, where enormous quantities of air came into contact with all parts of the pulp, that the CO_2 would become very much diluted with the air and pass away with the excess.

210 X Q. As a practical proposition, it would have been a matter of indifference in the operation of the Emu plant, would it not, whether the gas in the froth were air or carbon dioxide?

A. We were concerned only in the production of concentrates for smelting tests.

211 X Q. And therefore you did not find it necessary to make any determination as to whether the froth-forming gas was air or carbon dioxide? By determination I mean analysis of the gas in the froth?

A. We were so sure that the froth was an air-produced froth that we did not give the matter any serious consideration.

212 X Q. But as a matter of fact it did not make any difference to you, as long as you obtained your concentrate, whether the gas in the froth was air or carbon dioxide.

A. Our first consideration would have been economy of re-agents and we would certainly take every precaution to economize
313 sulphuric acid, and under no circumstances whatever would we have considered the production of a CO_2 froth when we had the enormous reservoir of air, namely the atmosphere, to draw upon, when this air could be used for froth production merely at the cost of agitation.

213 X Q. I am taking conditions as they were. You used a certain amount of acid under certain conditions for reasons which seemed sufficient to you. This amount of acid and these conditions being fixed and determined and in use, it was a matter of indifference was it not, so long as you obtained your concentrate, whether the gas forming the froth was all air or all carbon dioxide or partly air and partly carbon dioxide?

A. The consumption of acid is a matter of vital importance and we would not willfully consume this reagent for the production of CO_2 for froth production. Although not intending to take advantage of the accidental presence of this very small proportion of CO_2, we could not prevent it.

214 X Q. As a matter of fact this amount of CO_2 being present, due to the conditions under which you were operating, and whether that amount be small or large in your opinion, it was a matter of indifference so far as practical results were concerned, was it not, whether the froth-forming gas was all CO_2 or all air or a mixture of the two.

A. The first consideration in obtaining practical results is the strict economy of reagents, and as I have explained before, if the
314 consumption of sulphuric acid is high we can generally trace it to the presence of calcite in disturbing quantities, and under these conditions we try to avoid the use of sulphuric acid and economize by using an acid salt. The consumption of this acid salt is much lower than the acid and the production of CO_2 correspondingly small. You will see therefore that we make every effort to keep the production of CO_2 down for the economy of acid and acid salt. Therefore we regard the evolution of CO_2 in our agitators as being one of our biggest difficulties and I have spent nearly ten years in experimenting to overcome this condition. After many years of research I have succeeded in my object and ores like San Francisco del Oro ores and other ores of calcitic gangue are no longer a trouble to us, for we have now overcome this difficulty of high acid con-

sumption. Treatment of these ores can now be undertaken under much more economical conditions.

215 X Q. My question involves no consideration of economy or of whether you desire or do not desire to cause the evolution of carbon dioxide. On the contrary, the question is based upon the operations at Emu under the conditions stated by you. These conditions being fixed, and presumably, the best for the purpose intended, I would like to have you state whether under those particular conditions, wherein at times 275 cubic feet of carbon dioxide were evolved per ton of ore, and at other times a somewhat smaller amount, extending down to a minimum of 209 cubic feet of carbon dioxide,
315 it was a matter of any importance from a practical standpoint whether the froth-forming gas was carbon dioxide, air, or a mixture of the two. My question does not call for any reference to the variations in the amount of acid, but is restricted to the operations at Emu as defined by you. With that explanation will you please answer the question?

A. We certainly had to take the froth as it was formed.

216 X Q. And as long as you got that froth, from a practical standpoint, it was of no importance, was it, whether it contained air, carbon dioxide, or a mixture of the two, so long as it contained the requisite percentage of the valuable mineral in the requisite state of purity?

A. Our proposition was to produce the requisite percentage of the valuable mineral in a requisite state of purity under the most economical conditions, and as I have stated before, the last thing we wished was the production of carbon dioxide for the reasons before explained.

217 X Q. All of the conditions of operation having been adjusted, as I assume they were at Emu, upon the most economical basis, and the question of economy having been thus disposed of, then you were willing to take the froth provided it contained the right amount of sufficiently pure mineral, and it was a matter of indifference as to what particular gas, carbon dioxide or air, was wholly or partially responsible for the formation of the froth. That is correct is it not?

316 A. We were indifferent to this extent, that we knew that the gases causing the froth consisted of a very large proportion of air and accidental traces of CO_2.

218 X Q. But it was a matter of indifference, was it not, as to how much air there was and how much CO_2 in the froth, the conditions of operation having been adjusted to the economical basis you have described?

A. I can only repeat my last answer.

219 X Q. I am not asking you whether you knew how much air there was and how much carbon dioxide; I am asking you whether it made any difference, from a practical standpoint, how much there was of each of these gases, the conditions of operation having been fixed and settled upon the economical basis you have described?

A. We naturally had to take the froth as it was produced.

220 X Q. And you did this without finding it necessary to de-

termine how much of the gas of the froth was carbon dioxide and how much was air, or how much was made up of any other gases that might occur. Is that right?

A. We took the froth as it was produced, and as I have explained in a previous answer, no analyses of the froth gases were made in this particular case.

221 X Q. I presume the extended efforts which you have made, covering some ten years of time, to overcome the evolution of carbon dioxide, was caused by the fact that in operating the process
317 in which Minerals Separation, Ltd., have been interested, carbon dioxide has been evolved in appreciable quantities in many instances. Am I right in this?

A. We had never been able to treat ores with calcitic gangue in disturbing quantities without a very large consumption of sulphuric acid, and my efforts have been directed in reducing this to a figure that would be readily acceptable to any clients owning such mine ores.

222 X Q. The large consumption of sulphuric acid in treating calcitic ores was due to the reaction between sulphuric acid and calcite with an accompanying evolution of carbon dioxide, was it not?

A. Yes.

223 X Q. You have been asked what your experience was when, in using the agitation-froth process on a commercial scale, with a normal and proper consumption of one and a half pounds of oil per ton, you increased the oil feed to two and a half pounds per ton, and you stated that the mineral-froth lost some of its natural color and lustre, that the quantity of froth recovered on No. 1 box was lessened, that on No. 2 spitz and No. 3 spitz was slightly increased, and that the tailings showed increased losses of sulphide mineral, taking the form of agglomerations. Suppose you had increased the amount of oil under the conditions of the question referred to to five pounds per ton of ore, would the defective conditions have been still further increased?

318 A. Certainly.

224 X Q. And if you had gone up to fifteen or twenty pounds of oil per ton under the same conditions, what kind of a result would you have obtained?

A. I cannot answer this question, as I have had no experience of such conditions.

225 X Q. Suppose you had decreased the amount of oil to a quarter of a pound per ton under the conditions referred to above where the proper and normal feed was one pound and a half of oil per ton, what kind of a result would you have obtained?

A. I have never experienced such a condition in practice, and can only surmise what would take place.

226 X Q. You have said that with the oil reduced to half a pound per ton of ore the froth immediately diminishes in quantity and the color shows the presence of gangue. I take it that you have experimented, or experienced in practice this condition of half a pound per ton. Is that correct?

A. Yes. I have experienced this condition on occasions when I have been demonstrating to our clients at Broken Hill that it would be impossible to reduce the oil consumption below that at which we were operating, and so reduce the cost of treatment. I mean, of course, reducing oil consumption without loss of recovery or in any way affecting the practical value of our work.

227 X Q. You would not expect successful results with fifteen or eighteen pounds of oil per ton under those conditions where
319 a pound and a half per ton was the proper and normal feed?

A. You could get successful results on this quantity of oil by varying the conditions of agitation, namely, I should expect to have to make repeated agitations to beat more air into the pulp. I cannot say this definitely because I have never tried this wasteful quantity of oil in practice.

228 X Q. It is your idea then that with the larger amounts of oil more agitation would be necessary?

A. In this particular instance the agitation that would be necessary would be far beyond practical limits.

229 X Q. But whether practical or not, more would be necessary to produce the result?

A. I should expect so. The purpose of the extended agitation in this case would be for beating air into the pulp and not for the oil coating of the mineral.

230 X Q. You have referred to the use of emulsions containing oleic soap. Was there any difference in the action of these emulsions of oleic soap and the action of free oleic acid when used?

A. Do you mean an emulsion of oleic soap with other oils, or do you mean plain oleic acid soap solution?

231 X Q. I would like to have you describe the action of free oleic acid, a solution of oleic acid soap and an emulsion of oleic soap with oil, stating what differences there may be between the uses and reactions of these different agents.

320 A. I have used oleic acid and oleic soap for the re-agent in the agitation froth process. I have never used the emulsion of oleic soap with oil for this purpose but only in the Cattermole process.

The oleic acid is a convenient method of adding a straight oil to the agitation-froth process when temperature conditions are suitable and it is a freely running oil. In the cold weather oleic acid becomes solid and could be cut easily with a knife. Under these circumstances if temperature conditions are not raised to suit, the oleic acid cannot be added as an oil, and would never become disseminated through the agitated pulp. A convenient method for adding the oleic acid and getting it very finely divided throughout the acidulated pulp is to add it in the form of soap. The action of this soap I have described on a previous occasion in my testimony. The emulsion of oleic soap with oil was a convenient method in the cold weather for adding the necessary oil in the Cattermole process.

232 X Q. In observing the operation of the agitators in the plant at Emu how are you enabled to tell that air is being beaten in and

out again or to tell that the appearance you see is not caused by carbon dioxide as much as by air?

A. By looking into the mixers I notice that the beating or agitation of the pulp is very violent and I know that the peripheral speed of the outside of the four-armed agitator is over sixteen hundred feet per minute. There are four arms traveling at this speed
321 and the natural result of having only two inch clearance space from the side of the square vat forming the agitating vessel is that the mixing with air is of a most violent type and wants to be seen to be fully appreciated. The type of agitation takes the form of beating against the sides and on occasions the centre of the agitator can be discerned through the air space in the agitators.

233 X Q. What evidence is there upon observation of the apparatus such as that at Emu that air is beaten into the liquid and comes out again?

A. The agitation is of such a violent type that no other condition would be possible.

234 X Q. In your answer to Question 27 at the beginning of the answer, you describe a centrifugal stirrer. Can you make this description a little more clear?

A. This centrifugal stirrer consists of two circular sheets of metal held together by radial arms or ribs. The top sheet is unperforated and the lower sheet an annulus or with a hole in the middle through which the pulp is drawn upward and then thrown out between the discs. The best comparison in practice I can draw to your attention is the centrifugal pump, the part that I have described being the rotary part of the pump.

235 X Q. What are some of the acid salts which you have referred to as being used instead of free acid?

A. The most important of these is bisulphate of soda which is a molecular combination of normal sulphate of soda and sulphuric acid.

Cross-examination closed.

322 Redirect examination.

By Mr. Williams:

236 R. D. Q. You have described several tests of the Froment process made by you but have not stated what were the conditions of the water as to temperature. Please add this information.

A. The temperature condition varied between normal atmospheric temperature and a temperature of up to say 28° or 30° Centigrade. The reason why the steam coil was not used in the tests with the Froment apparatus was because there was no means of producing live steam in the laboratory for this purpose.

237 R. D. Q. You said in answer to 180 X Q, that in your operations in Australia the plants were run under such conditions that normally there was no free acid in the spitz boxes. What was the arrangement of acid feed and oil feed and heat application in these plants, and to what part of the apparatus were these feeds applied?

A. The acid was added in No. 1 agitator, the oil in No. 2 agitator. The steam was applied to agitator No. 1, occasionally to No. 2 and usually to No. 6 agitator.

238 R. D. Q. In your description, in answer to 121 Q. of the drawing produced by you, you did not refer to the letter F in that drawing. Please state what that letter represents?

A. This is the inclined deflecting baffle which is fixed in each spitz box.

323 239 R. D. Q. You have described a three-story plant at Charlotte Street in your answer to 55 Q. I now show you the drawing of Patent No. 953,746 to T. J. Hoover, dated April 5, 1910, and ask you whether or not this drawing represents one of the three units of that plant.

A. It does.

240 R. D. Q. How about the openings from agitation box to agitation box and from agitation box to spitzkasten?

A. They were three-inch holes instead of the horizontal slot shown in this drawing.

241 R. D. Q. Reference has been made by you to certain emulsions used in carrying on the tests of the Cattermole process. What symbols, if any, were used for these emulsions?

A. A typical example is 33.3% R_3 P_1 3.33% S S. This means 33.3% of the total emulsion consisted of a mixture of a residuum, namely R, and paraffine, namely P, mixed in the proportion of 3 parts of R and one part of P. SS signifies soft soap, and 3.33 per cent. of the total emulsion consisted of this. The rest of the emulsion was water.

242 R. D. Q. You have said that when you returned to the London Works from South Wales you saw Mr. Hyde, the defendant, at the London Works daily. Did you during this period, and before the departure of Mr. Hyde for the American continent, participate in any tests of the large testing plant then at the London Works?

324 A. Yes. We conducted a test on Broken Hill tailings at which Mr. Hyde was present for a portion of the time if not all.

243 R. D. Q. In your testing work in the London plant, and in that of other men in your presence, was anything done at any time in regard to the re-treatment of concentrates?

A. This has been common practice for several years. The object of re-treatment as I have explained before was to increase the grade of the dirty concentrate produced in a primary operation where very high recoveries were obtained. Economy of re-agents is sometimes made in this way and I have frequently carried out tests under these conditions.

244 R. D. Q. You have said that this has been common practice for several years but I wish you would be more specific and fix the date in relation to Mr. Hyde's presence at the Minerals Separation London Works in the Spring of 1910 and the Winter of 1910-1911.

A. Personally I was interested in this re-treatment scheme before my departure to the Caucasus Mine in the Autumn of 1909. After

my return from South Wales and since that date the method has been our common practice.

245 R. D. Q. If as a result of the re-treatment of a concentrate, a residue is obtained which is comparatively rich in mineral, what is the proper metallurgical practice as to what is to be done with this residue.

A. These residues are considered as middlings and as such
325 are mixed with the crude feed to the primary plant and re-treated in this manner.

Redirect examination closed.

Deposition closed.

GEORGE A. CHAPMAN.

ALLEN CRAWFORD HOWARD, a witness produced on behalf of the complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. What is your name, age, residence and occupation?

A. Allen Crawford Howard, twenty-nine, Rochford, Essex; Works Manager of Minerals Separation Ltd., one of the complainants.

2 Q. How long have you been employed by Minerals Separation and in what successive positions?

A. I was employed as an assistant engineer to Minerals Separation Ltd. from February 10th, 1908, to January 1st, 1910, when I was appointed manager of their London testing works, which position I still hold.

3 Q. What are your duties as Works Manager, generally?

A. My duties are to supervise the testing work on all ores received at the works and to assist in the design and erection of plants, and I am in control of the staff engaged at the works.

4 Q. Do you know the defendant, Mr. James M. Hyde?

326 A. I made the acquaintance of Mr. James M. Hyde in the latter part of February, 1910, at the office of Minerals Separation where he was introduced to me by the consulting engineer, Mr. T. J. Hoover, as having joined the staff of the Company.

5 Q. What did you observe as to Mr. Hyde's occupation at the office of Minerals Separation, immediately after his arrival there?

A. Mr. Hyde was given a file of the Company's Patents and other patents dealing with the flotation concentration of ores, together with a number of files containing reports of tests which had been made on ores submitted to the Company from time to time. He was engaged in the study of these, and discussed them with me from time to time.

6 Q. Did Mr. Hyde say anything to you as to the extent of his knowledge on the subject prior to his coming to the office of the Company, and if so, what did he say?

A. Mr. Hyde told me on more than one occasion that the work was entirely new to him. That he had known that Mr. Hoover was engaged by the Company who treated ores by oil flotation methods, but of the details of flotation work he had had no experience, and he asked me to assist him by giving him all the information I could, as he anticipated that his stay in London during that visit would be of short duration.

7 Q. Did you do anything further in the way of putting Mr. Hyde in possession of information as to the Minerals Separa-
327 tion work, and if so, what did you do and where did you take him?

A. In accordance with Mr. Hoover's instructions, I took Mr. Hyde to our London Testing Works, which were then at 31 Charlotte Street, London, E. C., and I instructed every member of my staff that Mr. Hyde was to have free access to every part of the works; that any questions he asked were to be answered to the best of their ability. I personally explained to Mr. Hyde the details of the construction of our large scale testing plant, and I arranged for him to be instructed in the details of the process first by Mr. A. H. Higgins, who was at that time our senior metallurgist, and then I arranged for Mr. Hyde to share a room with Mr. E. W. Wilkinson, one of my assistants, who was engaged in carrying out small scale tests. I repeatedly enquired of Mr. Hyde whether he was getting all the information which he required, and he expressed himself entirely satisfied with the arrangements which I had made for his instruction in the theory and practice of the processes owned by my Company.

8 Q. Can you call to mind any specific statement of Mr. Hyde to you as to the extent of knowledge which he had thus acquired from any of the members of your staff, and if so, will you kindly repeat such statement or statements?

A. Referring to the instructions which he had received from Mr. A. H. Higgins, Mr. Hyde informed me that he congratulated himself that he had sucked Mr. Higgins' brains dry.

328 9 Q. Please describe generally any large scale testing plant which was at these London Works during the period of Mr. Hyde's visits there of which you have testified?

A. The large scale plant consisted of seven rectangular mixing compartments, together with three flotation boxes which were connected with the agitating or mixing boxes before referred to, by means of a flexible rubber connector, consisting of three-inch flanged rubber piping. The tailings were conveyed from the bottom of the first and second frothing boxes to the succeeding agitating box by means of a pneumatic injector or lift pump.

10 Q. Please name the agitating or mixing boxes in numerical order, and the frothing or flotation boxes in numerical order, and give the course of the pulp through the apparatus?

A. I will do so, referring to the drawings which you have handed me at my request. The pulp entered the mixing box 1 and flowed through 2 to 3. From there it passed through the rubber connector to the first frothing box. From the first frothing box the residues

passed by means of the air lift to the fourth mixing box. They were re-agitated in this box and passed to No. 5 mixing box, and thence to frothing box No. 2. The residue from frothing box No. 2 passed through the second air lift to mixing box No. 6, where it was re-agitated and passed to No. 7. It was also re-agitated in No. 7, and delivered to frothing box No. 3. The final residues from this box passed generally to waste.

11 Q. And what happened to the concentrates from frothing
329 boxes 1, 2 and 3?

A. They passed as a froth over the lip into launders, which delivered them to a common concentrates settling-box, designed with a view to breaking down the thick coherent froth, in order that the surplus water might overflow without loss of the valuable metalliferous contents of the concentrates.

The Commissioner notes that the drawing handed to the witness, and referred to by him in the last answer, was "Complainant's Exhibit Drawing of 1909 and 1910 Agitation Frôth Plants."

12 Q. Please state whether or not this apparatus was exhibited to Mr. Hyde, either in operation or when not being operated?

A. Mr. Hyde had the entire run of the Works, and I frequently explained in detail to Mr. Hyde the construction of this plant. On one occasion he was shown this plant in operation, when all three of the flotation boxes were continuously delivering to the concentrates-vat a thick froth. The ore treated was Broken Hill tailings, and the plant was operated by Mr. G. A. Chapman. Mr. T. J. Hoover, the consulting engineer of the Company, and Mr. Edward H. Nutter, a member of our staff, were present with Mr. Hyde on this occasion.

13 Q. Please state whether or not the drawing referred to
330 by you, "Complainant's Exhibit Drawing 1909 and 1910 Agitation Froth Plants," is a substantially correct representation of this large testing plant at the London Works, which was exhibited to Mr. Hyde, as you have described?

A. It is such.

14 Q. You will note that the drawing does not include the agitators. Please describe the construction of agitators as they were present in that plant?

A. The agitator consisted of a four-bladed impeller. Each blade was curved rearwardly. The agitator was carried on a vertical spindle which extended down within two inches of the bottom of each agitating box and was supported above the agitating boxes by two plummer blocks. The spindle was held by a collar secured to it by a set screw. Between the top plummer block and this collar a ball bearing was inserted to reduce friction.

15 Q. You have said that the residues or tailings from this plant usually went to waste. Was any apparatus provided at the works for the treatment of these residues or tailings, and if so generally what kind of an apparatus was it, and to what extent was it used?

A. There were eight film flotation boxes installed underneath this plant. The idea was to pass the residues from this plant over these boxes with a view to increasing the total recovery, but it was found in

practice that so high a recovery was obtained from the flotation boxes that it was seldom considered necessary to further treat the
331 residues from the flotation-boxes by passing them over these film-flotation boxes. To all practical purposes their use was abandoned.

16 Q. I take it then that they were not used when the flotation plant was exhibited to Mr. Hyde at work?

A. They were not used on that occasion as the appearance of the flotation tailings indicated that there was no necessity to pass them through the film flotation boxes. The tailings were sent direct to the sump.

17 Q. You have referred to a Mr. E. W. Wilkinson as one of your staff who was engaged in work with Mr. Hyde. Was Mr. Wilkinson a proficient test operator at the time when Mr. Hyde first entered the plant or if not, what would you say as to his proficiency?

A. He was proficient.

18 Q. What has been your experience as to the time required to produce a proficient test operator from such men as you employed for that purpose on the staff at the London Works of Minerals Separation Ltd.?

A. I have found, in the case of the type of men we employ on this work, that after being in the works from a fortnight to three weeks they are quite proficient in the work of testing ores submitted to us. I have no hesitation in entrusting such work to them. The operation of our process is so exceedingly simple that proficiency is easily acquired within the limits of the time mentioned.

332 19 Q. I now show you a piece of apparatus marked for identification "Sulman & Picard Slide Machine." Please state when you first saw an apparatus of this identical construction, or possibly this identical apparatus, whatever is the fact?

A. I saw an apparatus identical with this at the laboratory of Messrs. Sulman & Picard early in February, 1910.

20 Q. Please state what you know in regard to the development or construction of apparatus of the type of this slide machine.

A. In the latter part of 1909, Mr. Theodore J. Hoover frequently discussed with me the possibility of designing a small-scale testing apparatus which would enable our operators to turn out more work in a given time than they were able to do with the apparatus then in use. We discussed several possibilities and early in February, 1910, Mr. Hoover informed me that Messrs. Sulman & Picard, our consulting metallurgists, had installed at their laboratory a new type of testing machine which was an immense improvement on anything which he and I had so far thought out. He told me that they had named the apparatus the Shear Gabbett," and he briefly outlined the construction to me. He at once set about the preparation of plans and details of a machine embodying the principle of the shear Gabbett and discussed with me the material from which it should be made and its dimensions. He instructed me to find out from Mr. Higgins the exact sectional area of the rectangular testing
333 Gabbett then in use, and to measure the depth of the normal charge of ore and water inserted in this machine, and to note the depth of the under surface of the froth formed in making a test.

This I did and from the information supplied by me, Mr. Hoover himself drew out a complete plan for the construction of a shear Gabbett, or as he preferred to call it "The Slide Machine." About the date of the completion of this plant Mr. Hyde arrived in London and shortly afterwards Mr. Hoover instructed me to take this plan to W. H. Dearden & Co., of Clapham, London, S. W., and explain the construction to them with a view to their quoting us for the manufacture of a machine. I was very busy at the time and Mr. Hoover said that provided I explained the details to the maker I could leave Mr. Hyde to follow the matter up. Mr. Hyde himself visited another firm of engineers and arranged for a second machine to be made. I had no part in the ordering or manufacture of this second machine, which proved quite unsatisfactory, and no further orders were placed with this firm.

I may add that Mr. Hyde went with me to W. H. Dearden & Co. and was present when I explained the machine to Mr. W. H. Dearden and that the machine which was made by W. H. Dearden & Co. was a satisfactory machine, although sundry minor improvements were introduced in subsequent machines.

Adjourned to Wednesday, the 28th August, 1912, at 10.30 at the same place.

334 London, August 28, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination of Mr. Howard continued:

21 Q. What was done with the slide machine made by W. H. Dearden & Co., when delivered to Minerals Separation Limited?

A. When the machine was delivered at the works I instructed Mr. Hyde and Mr. Wilkinson to test its possibilities. I recollect that at the end of their first morning's work they had not been able to produce any flotation and were unable to account for this. On a careful examination of the machine I found that the maker had fastened down the rubber sheet with some form of glue and I knew that any trace of glue would be sufficient to destroy, or rather to prevent, flotation. On removing the rubber sheet and cleaning it and the machine from all traces of glue it was found, on starting up the machine again, that an excellent froth was produced and from that time onwards the operation of the machine presented no difficulty.

22 Q. Will you produce, if possible, the test machine which was the immediate predecessor of the slide machine described by you?

A. I will, and do.

23 Q. Please describe the machine produced by you.

335 A. This machine produced by me is one of the machines in use immediately before the installation of the slide machine. It was used by Mr. Higgins in his small scale experimental work. The machine consists of a rectangular agitating vessel, the bottom and two of its sides being of wood. The remaining two sides are of glass. The vertical spindle provided with a cross-blade agitator was suspended from a motor placed above the machine, enabling a violent

agitation of the contents to be effected. At the bottom of one of the wooden sides is a small hole into which a glass pipe was inserted to enable the contents to be drawn off. At the outer end of this glass pipe rubber tubing was fastened and provided with a pinch cock to enable the operator to control the discharge. The apparatus also consisted of a series of two small spitzkasten each provided with a small feed launder or apron, and a concentrates-launder.

24 Q. I call your attention to that part of the answer of the defendant to question 4 appearing in Defendant's Record, pages 46 and 47, wherein he describes a rectangular wooden box having two glass sides, and ask you first whether or not this is the apparatus thus described, and secondly, whether or not his description of the mode of operation of this apparatus is accurate?

A. To the first part of your question my answer is yes. To the second part of your question the defendant's statement is incorrect inasmuch as it states that the oiled mineral matter floated off as a surface film. In the proper operation of the apparatus, and
336 as I have repeatedly seen it operated, the concentrates are discharged or float off in the form of a coherent froth. In other particulars the description of the operation is substantially correct, with this exception, that when the agitation ceased and the mass was allowed to come to rest it would rise to the surface forming a thick coherent froth varying in thickness according to the mineral contents of the charge of from ¾ of an inch to 1½ inches or even more.

25 Q. Apart from the slide machine which you have described, were there any other efforts made to improve the apparatus which you have just produced?

A. It was the desire of Mr. Hoover and myself as I have before stated, to devise some type of apparatus which would increase the output of work per man, per day, and with this end in view I suggested to Mr. Hoover at the end of 1909, that if we were able to insert a sliding door on one side of this machine it might be possible by that means to draw off the froth immediately the agitation was stopped by merely lowering this door. Such a machine was made and I am able, if so desired, to produce it, and at request of counsel I have now produced it for inspection. This machine did not work satisfactorily and after careful trial of its possibilities its use was abandoned.

By Mr. Williams: The apparatus produced by the witness in answering 22 Q. and described by the witness in answering 23 Q.
337 is put in evidence and marked "Complainants' Exhibit Square Test Apparatus."

26 Q. I call your attention to a part of the testimony of the defendant in his answer to 4 Q., appearing at page 47 of Defendant's Record, and reading as follows—referring to Mr. T. J. Hoover and myself by the pronoun "we":

"Together we designed a machine similar to and probably the same
" as the machine referred to as the slide test machine by Dr.

"Chandler, and Mr. Nutter in their testimony. I had several of "these machines built in London and remained in the City long "enough to develop a system of tests by the use of this apparatus "and to instruct Mr. Wilkinson, an attache of Minerals Separation, "Limited, in the use of this apparatus."

Please state whether or not this is a true and accurate statement.

A. This statement is untrue.

27 Q. Again I call your attention to the testimony of the defendant in answer to Question 5, appearing on page 48 of Defendant's Record, and particularly to the statement

"The oiled mineral particles flowing down the inclined apron were "exposed to air and floated off as a film upon the surface of the "water."

338 Please state whether or not the part particularly referred to is true, and what criticisms you may have as to any other statements in that answer.

A. The statement particularly referred to is untrue, to the extent that the mineral particles floated off as a film upon the surface of the water. The oiled mineral particles floated off in the form of a froth, although if an excess of water was allowed to overflow at the concentrates overflow lip the froth would of necessity be thin. As to the theoretical part of this answer I prefer not to express my opinion, but I state that in the apparatus in use in our London Works during the whole period of my management the mineral particles when leaving the agitating vessel have always been removed in the form of a froth. The statement that the slide machine was designed by Mr. Hoover and Mr. Hyde is untrue.

28 Q. I call your attention to the testimony of the defendant in answer to X Q. 128, particularly the portion thereof appearing at the top of page 103 and reading as follows, the "we" being Mr. T. J. Hoover and Mr. Hyde:

"We discussed the matter together, making several sketches, de- "tails of each being contributed by each of us, and finally decided "upon the form which was finally constructed. Such computations "as to size as were necessary were made by me.

"The machine as originally designed was constructed under
339 "my supervision, was tested by me, and was modified under "my supervision in a number of minor features after the first "tests were made."

Are or are not these statements true?

A. The first paragraph quoted is untrue to this extent that the machine embodying the principle of the slide machine was already in existence, that the plan for the machine, made by W. H. Dearden & Co., was completed before Mr. Hyde arrived at our London office, and that such computations as to size as were necessary were not made by Mr. Hyde, but were made by Mr. Higgins and myself and communicated by me to Mr. Hoover.

As to the second quoted paragraph, the facts are as I have stated. Mr. Hyde probably did something as to minor alterations of the apparatus after the first tests were made.

29 Q. During the period from Mr. Hyde's departure in the Spring of 1910 until his return in December, 1910, and after his return in December, 1910, what within your knowledge occurred in relation to tests of ore specimens?

A. During Mr. Hyde's absence in Mexico, United States and Canada, he sent home a large number of samples of ores and mill products to be tested. He also brought with him some samples to be tested. The samples sent by him were tested by Mr. A. H.
340 Higgins and the tests were reported to me, and the reports were handed by me to Mr. Hoover or to the Secretary of the Company, Mr. A. O. Williams. After Mr. Hyde's return he was constantly in the works and discussed with Mr. Higgins, Mr. Nutter and myself the result of the tests carried out in his absence and he personally supervised the testing of the samples which he brought with him, on this visit to England.

30 Q. Did any of these tests involve re-treatment of the concentrates and if so, will you give an example?

A. A report on the testing of a sample of Tecolotes slime products by Mr. A. H. Higgins, dated January the 4th, 1911, suggests the re-treatment of the lower grade concentrates in commercial practice. This report was handed to me by Mr. Higgins and before sending it into the office of the Company I showed it to Mr. Hyde, who read it, and discussed it with Mr. Higgins and myself. I believe that there are other references to the re-treatment of concentrates in Mr. Higgins' report on the testing of Mr. Hyde's specimen, but I have selected this as an example. I now produce the original report.

By Mr. Williams: The report produced dated January 4th, 1911, is offered in evidence as "Complainants' Exhibit Higgins' Report, January 4, 1911." The particulars of assays annexed to the report are produced for inspection, but not offered in evidence.

341 31 Q. Please describe any large scale testing apparatus which was in use in the London Works of Minerals Separation Limited when Mr. Hyde returned to London in December, 1910.

A. The large scale testing apparatus consisted of a series of eight agitating compartments and five flotation boxes. The ore pulp was fed into the first box and passed from the first through the second and third and fourth mixing boxes, where it was liberated through a four-inch brass pipe to the first flotation box, flowing over a flaring deflecting mouth. The tailings from this frothing box were elevated to the succeeding agitating box through a cast iron pipe. The agitator performed the function of a centrifugal pump in the work of drawing the tailings up to the agitation box from the preceding frothing box. The pulp passed directly from the fifth agitation box to the second frothing box, in the same manner as in entering the first frothing box, and the tailings of the second frothing box were again drawn by the agitator of the sixth mixing box in the manner

above described. This continued to the end of the eighth mixing box and the fifth frothing box, from the bottom of which frothing box the tailings were discharged into a launder delivering them to the tailings vat. The discharge of tailings from the fifth frothing box was governed by means of a slicing tap or outlet valve. The plant was erected on, and secured to, a rigid timber framework which prevented any excessive vibration. The frothing boxes were
342 secured to the mixing boxes with three-inch brass screws and by the four-inch brass pipes or flanged bushings previously referred to in this answer.

A violent agitation was imparted to the pulp by means of four-bladed agitators, one in each mixing compartment, the blades having inclined faces. Each of these agitators was fastened to the lower end of a shaft suspended from the framework.

32 Q. In this plant, were the frothing boxes respectively in line with the agitation boxes which discharged their contents into them?

A. They were.

33 Q. And were the agitation boxes and frothing boxes respectively clamped together by the screws which you have mentioned?

A. They were.

34 Q. So that the four inch brass bushing was merely the lining of a hole extending from the agitation box to the frothing box in each instance? Is that correct?

A. That is so.

35 Q. In addition to the large scale testing apparatus consisting of eight agitation boxes and five frothing boxes which you have described, was there any other large scale apparatus at the London Works when Mr. Hyde returned to London in December, 1910? If so, please describe this apparatus.

A. At these works, which were at King John's Court, Oliver Lane, London, E. C., there was also another plant which was nearing completion at the time of Mr. Hyde's return to London and which
343 was completed within the following week. This plant consisted of ten agitating compartments, with a compartment between each agitating compartment designed with the object of removing a low grade concentrate which could afterwards be delivered to the other plant already described in detail, for the purpose of obtaining a high grade concentrate by such re-treatment. The idea was that in the first plant a practically complete recovery of the mineral values would be obtained, and that in the subsequent treatment the concentrate would be raised in grade to a saleable value.

36 Q. I now show you the drawing of British Patent No. 23949 of October 15, 1910, to Edward H. Nutter and Theodore J. Hoover, and ask you whether or not the drawing of that patent represents the apparatus which you have just described, having in mind that only four of the ten agitators appear in this drawing.

A. It represents the apparatus.

37 Q. By what name was this apparatus known?

A. It was known as the "Differential Plant."

38 Q. Were any tests of this apparatus made in the presence of Mr. Hyde? If so, please relate the particulars.

A. A large number of tests were made in this apparatus in the presence of Mr. Hyde during the first half of January, 1911.

39 Q. Please state whether or not you were present at any
344 discussions of the principles and intended mode of operation of this apparatus when Mr. Hyde was also present?

A. I frequently discussed with Mr. Nutter and Mr. Hyde the principle of this plant and the advantage of aiming in the first treatment of ores at a high recovery and then raising the grade of the concentrates by re-treatment. This was an accepted mode of treatment at the works and this apparatus was designed to carry it out, in connection with other points.

40 Q. You have said that re-treatment was an accepted mode of treatment at the Works. When first did you learn of the re-treatment of concentrates?

A. Mr. Hoover discussed this with me in connection with some tests which we were carrying out on the ore of the Caucasus Copper Company in Russia. This was in the month of October, 1909, when we were both at the Mine in Russia, together with Mr. George A. Chapman. It was new to me, but did not appear to be new to Mr. Chapman.

41 Q. Afterwards, was this subject of re-treatment given consideration, and if so, to what extent?

A. It was part of our established practice at the Works, and when I took up my duties as Works Manager it was already established and has continued to the present day. I have assisted in planning, in all, three commercial plants for re-treatment, these plants being the Braden Plant, the Saxbergets Plant and the Cuba Copper Company's Plant. Re-treatment tests have been of frequent oc-
345 currence, certainly since January 1, 1910.

42 Q. Now as to the standard testing plant having eight agitating boxes and five frothing boxes, please state whether or not this plant was operated in the presence of the defendant, and if so, relate the particulars?

A. This plant was operated in the presence of Mr. Hyde on at least one occasion. That occasion was on the 5th January, 1911, when we were treating a mixed copper-zinc ore. The ore floated readily and all five boxes were continuously discharging a thick, coherent froth.

43 Q. How do you fix the date of this occurrence?

A. I fix the date of this occurrence by the fact that on this and the preceding and succeeding days some samples of a cobalt nickel ore brought by Mr. Hyde to the works, were being tested under his direct personal supervision, and that he was called down from upstairs, when we were ready to run the plant, to witness the run. My works' daily report for that day identifies the test.

44 Q. Before Mr. Hyde left the services of your company, were you requested to prepare for him any document or memoranda of instructions, and if so, please relate the circumstances?

A. Mr. Hyde told me that he was expecting to return to America shortly in the service of the Complainants and he asked me to give him a note of any practical working details of which I had,

346 or could obtain, knowledge, as to the working of our plants in continuous practice, particularly as to which oils were generally suitable for different types of ore and which oils usually required temperature. I discussed the question with him and promised to prepare a complete memorandum. Soon after this he left the service of the Complainants and a few days afterwards I received a letter from him which I now produce and which I recognize to be in his handwriting:

By Mr. Williams: The document produced by the witness is offered in evidence and marked "Complainants' Exhibit Hyde Letter February 7, 1911."

Direct examination closed.

Cross-examination.

By Mr. Scott:

45 X Q. Was United States Patent 835,120, this being the Patent involved in this Suit, among the file of Patents which was given to Mr. Hyde as testified by you?

A. I have frequently seen it in the file of Patents which was handed to Mr. Hyde but I am unable to testify whether it was in that file at the time it was handed to Mr. Hyde.

46 X Q. You are familiar with the Patent I refer to are you not?

A. I have not made a careful study of it, but I have read the Patent.

347 47 X Q. Did you give any instructions to Mr. Hyde or did you personally know of any instructions being given to Mr. Hyde other than the information contained in that Patent, such other information being necessary to enable Mr. Hyde to carry out the process which Minerals Separation, Limited, was exploiting for the flotation-concentration of ores?

A. I personally gave Mr. Hyde no instructions but as I have already stated I arranged for Mr. Hyde to be instructed in the operation of Minerals Separation Process and he expressed to me his satisfaction with the instructions he had received.

48 X Q. Do you know from your own knowledge whether Mr. Hyde received any instructions from anyone connected with Minerals Separation, Limited, necessary for the operation of the process being exploited by Minerals Separation, Limited, other than the information set forth in United States Patent 835,120?

A. I know that Mr. Hyde saw a large number of tests carried out at our London Works.

49 X Q. Did you consider it necessary in the exercise of your duties to impart to Mr. Hyde directly, or through others, information not set forth in United States Patent 835,120, in order to enable him to operate the process which that purports to set forth?

A. My instructions from Mr. Hoover were to the effect that Mr. Hyde was to have free access to our London Works and that every member of my staff was to give him all possible assistance,

348 and that I should hand Mr. Hyde over to Mr. Higgins in order that he might be instructed in the art of making tests.

50 X Q. In instructing the various new employees of Minerals Separation, Limited, in the operation of the flotation concentration process being exploited by that Company, did you customarily use United States Patent 835,120 as a medium of conveying to these new employees the necessary information?

A. I am unable to testify to that as I do not personally instruct employees who enter into our service in the art of our process.

51 X Q. And you do not know then whether United States Patent 835,120 was, or was not, used as a medium for conveying the necessary information to new employees to enable them to operate the process being exploited by Minerals Separation, Limited?

A. As I do not personally instruct new employees in the art of our process it is not possible for me to testify on this point.

52 X Q. You can state whether you know or do not know whether Patent 835,120 was used in the way I have described. I merely ask you whether you know or do not know that the Patent referred to was used in the manner I have described?

A. I am unable to testify that it was so used, and I am unable to testify that it was not so used.

53 X Q. What has become of the two small spitzkasten and the feed launder or apron which you state originally formed part
349 of Complainant's Exhibit Square Test Apparatus?

A. They are still in existence to the best of my knowledge.

54 X Q. Do you know why they were not brought here as a part of this exhibit?

A. I have no knowledge.

55 X Q. After the construction of the slide machine what was done with Complainant's exhibit square test apparatus?

A. It was left where it was in Charlotte Street at that time, and removed to King John's Court.

56 X Q. Was Complainants' Exhibit Square Test Ma .ine used for making tests after the construction of the Slide Mach' e?

A. It was.

57 X Q. For how long a period was it used after the construction of the Slide Machine?

A. For at least the period during which the Works were situated at Charlotte Street, and afterwards I believe the Slide Machine being substituted in a large number of tests, on account of its allowing more rapid work. Thus a larger number of tests could be performed in a given time than with the apparatus referred to as Complainants' Exhibit Square Test Machine.

58 X Q. About how long was this period during which the Square Test Machine was used concurrently with the Slide Machine?

350 A. I cannot state the period definitely, but I believe it was about twelve months, when owing to the very large number of tests which we were called on to make we installed a considerable number of Slide Machines with a view to expediting the work.

59 X Q. How large a proportion of the testing was done with Complainants' Exhibit Square Test Machine as compared with the testing

done with the slide machine during the period of concurrent use of the two types of machine?

A. I have no data to justify me in giving a figure.

60 X Q. Was the Square Test Machine in continuous use during that period?

A. Would you be kind enough to define what you mean by continuous use?

61 X Q. Was the machine always used by one or more of your operators?

A. That I am unable to say.

62 X Q. How many of the Slide Machines were in existence at this period of concurrent use of the two types of machine?

A. I presume you mean by in existence, in use at our London Testing Works?

63 X Q. Yes.

A. There were two or three.

64 X Q. And how many operators were there engaged upon testing work?

A. The number varied from two to four or five.

65 X Q. And you do not know whether any one or more
351 of these operators gave preference to the Slide Machine for their work?

A. As I already have said one of the principal advantages of the Slide Machine was that it allowed an increase in the output of a man's work.

66 X Q. And there you mean that the operators did give preference to the Slide Machine after it was introduced.

A. I am unable to testify as to the operators' preferences.

67 X Q. Did you see the Square Test Machine in use frequently after the introduction of the Slide Machine?

A. I have seen it in use.

68 X Q. Frequently?

A. Not as often as I have seen the Slide Machine in use.

69 X Q. Has the Slide Machine any advantages other than the possibility of carrying out tests more rapidly than in the Square Test Machine?

A. Yes, it occupies less room.

70 X Q. Has it any other advantages?

A. On account of its small size it is possible to collect almost the whole of the material put into it, whereas in the type of apparatus referred to as the Square Test Machine there is a greater loss of material due to the larger size of the machine.

71 X Q. In what way does this material become lost?

A. In carrying out a test it is quite impossible to prevent
352 some small percentage of the charge being left in the crevices of the apparatus. This inevitable loss is obviously less in the Slide Machine than in the Square Mixer.

72 X Q. About when did you last see the Square Test Machine in use?

A. I have seen it at use in King John's Court but I am unable to give a date.

73 X Q. In what manner was it being used then, that is, was it being used in connection with the apron and spitzkasten?

A. It was.

74 X Q. Did you ever see the Square Test Machine used without the apron and spitzkasten?

A. I have seen it so used.

75 X Q. Do you know what the occasion was of so using it?

A. I do not.

76 X Q. Did you take an active interest or participation in what was going on in the laboratory or testing plant of Minerals Separation Ltd.?

A. My position is an administrative position and I do not make tests myself.

77 X Q. Can you state what kind of a test would be made with the Square Test Machine without the apron and spitzkasten as distinguished from the kind of test that would be performed with the apron and spitzkasten?

353 A. I have seen the Square Test Machine used without the apron and spitzkasten, in which case the froth forming on the surface was removed with a bent spoon.

78 X Q. Did you know what prompted the operators to use the Square Test Machine in the way you have described, that is without the apron and spitzkasten?

A. I presume it would be with the object of saving time.

79 X Q. Is the Square Test Machine in use at all — the present time?

A. I have seen it used as recently as March, 1912.

80 X Q. Do you know what the purpose was of using it at that time, that is, was it in the regular course of business?

A. It was used by Mr. Henry Lavers, a metallurgist in the employ of my Company, for the purpose of carrying out a test on the Braden Copper Company's ore before he proceeded to Chili to operate my Company's process at their mine.

81 X Q. Was the ore of this Company tested in the Slide Machine at that time?

A. The ore of this Company had been tested in the Slide Machine at that time.

Cross-examination closed.

Redirect examination.

By Mr. Williams:

82 R. D. Q. Have you sent for the two small spitzkasten which were used with Complainants' Exhibit Square Test Apparatus, and if so with what result?

354 A. I have sent for this apparatus and have obtained one of these spitzkasten which I now produce and identify. The other one was sent to New York just prior to the taking

of the prima facie testimony in this suit, and is now, I believe, in the possession of our New York expert, Dr. Charles F. Chandler.

Redirect examination closed.

Deposition closed.

ALLEN CRAWFORD HOWARD.

It is stipulated that if Giovanni Battista Zanardo were called as a witness that he would testify that he received from Alcide Froment, the communicator named in the British Patent No. 12,778 of 1902, the document marked for identification "Froment Description" and the drawings marked for identification as "Froment Plan" and "Froment Drawing A" and forwarded the same to Mr. John Ballot, the present Chairman of Minerals Separation Limited, one of the complainants, during the latter part of December, 1903, and that this stipulation shall have the same force and effect as the deposition of this witness, taken under the present Commission, the right of cross-examination being waived.

By Mr. Williams: The apparatus produced by the witness, Allen C. Howard, in answer to 82 R. D. Q., is offered in evidence
355 and marked "Complainants' Exhibit Spitzkasten of Square Test Apparatus."

WILLIAM HENRY BALLANTYNE, a witness produced on behalf of the complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. What is your name, age, residence and occupation?

A. My name is William Henry Ballantyne; age, thirty-one years; residence, Streatham, London, S. W., England; occupation, Chartered Patent Agent and Consulting Chemist and Engineer.

2 Q. Please state your education and experience with reference largely to metallurgical matters?

A. I received my first technical education in Allen Glen's Technical School, Glasgow, where I studied engineering and chemistry. Subsequently I proceeded to the University of Glasgow and studied engineering, chemistry and metallurgy. I took the degree of Bachelor of Science. For some time I was engaged in practial engineering with a firm occupied chiefly in the manufacture of crushing machinery, centrifugal machines and the like. In 1900 I joined the firm of Boult, Wade & Tennant, Chartered Patent Agents, as a technical assistant, and continued my study of engineering, chemistry and metallurgy, taking up two special college courses of
356 metallurgy in London. From 1900 to the end of 1905 I worked as a technical assistant to Messrs. Boult, Wade & Tennant, Chartered Patent Agents, devoting the majority of my time to metallurgical work. In 1905 I became a Chartered Patent Agent

and in 1906 I became a member of the firm of Boult, Wade & Tennant, and since that date my work has continued to be largely on metallurgical subjects.

I am a member of various scientific bodies, including the Chemical Society and the Society of Chemical Industry. I have a private laboratory near my own house where I do experimental work.

In my own practice I have acted for a very large number of inventors of processes for the treatment of ores and I have come into contact almost daily with the many processes which have been proposed both for concentrating and smelting ores.

3 Q. Please now state your experience in connection with the oil processes of ore concentration.

A. I first studied the subject of ore concentration by oil in July, 1902, on behalf of my firm's clients, Messrs. Burdon & Co., who proposed to operate a process of the bulk oil flotation type, that is to say a process in which metallic sulphides are floated in water by a body of viscous oil and by virtue of the buoyancy of the oil. In this connection I closely examined the Elmore Patents, the Robson & Crowder Patents and various other earlier patents. When I joined my firm in 1900 they had already been acting for Mr. Sulman
357 for many years and since that date I have constantly acted for Messrs. Sulman & Picard and for a number of their clients and associates. I have advised them constantly on processes relating to the concentration of ores by oil and have very frequently been present at their investigations and have personally conducted tests in conjunction with them and their associates and assistants.

I first met Arthur Edward Cattermole early in November, 1902, when he was introduced to me through Mr. Sulman, by a Mr. Edwards, and upon Mr. Cattermole's instructions I obtained provisional protection in Great Britain for his processes. This was before Mr. Cattermole had come into contact with Mr. Ballot.

I first met Mr. Ballot in the latter part of 1902 when he took up a process of treating gold ores which was then being investigated by Messrs. Sulman & Picard. I already knew Dr. Gregory. In December, 1902, Mr. Ballot and Dr. Gregory informed me that they, and Messrs. Sulman & Picard, proposed to take up the Cattermole process with the object of forming a company to exploit it, and from December, 1902, up to the present time I have been in constant touch with Messrs. Sulman, Picard and Ballot and their assistants in the investigation and exploitation of processes for the concentration of ores, and I have acted as their adviser on matters relating to patents. I have also prepared their patent specifications. I have acted
358 as expert in a number of patent suits in England and other countries on the subject of ore concentration by oil. I have also acted in a similar capacity in oppositions, interferences, and other proceedings before the Patent Offices of various countries. Indeed I may say that a great part of my time every month during the past ten years has been occupied with these matters.

4 Q. You have mentioned in your last answer Messrs. Sulman, Picard and Ballot. Please state whether or not the gentlemen referred to are the patentees of the patent in suit.

A. They are.

5 Q. You have also mentioned Dr. Gregory. Please state whether or not he is one of the directors of the Complainant Corporations.

A. He is.

6 Q. Referring now to the Elmore process, as set forth in Patents Nos. 676,679 and 689,070, please state your experience in tests of the processes therein described.

A. I first saw the Elmore bulk-oil flotation process tested in the latter part of 1902, and I have, on many occasions since that date, tried the processes under different conditions and with different ores. These processes are set forth in the two patents to which you have referred, the latter differing from the earlier only in that it describes the use of an acidified ore pulp as distinguished from a neutral ore pulp described in the earlier patent. I have seen a plant for carrying out the Elmore bulk oil process with acid pulp on a com-
359 mercial scale, but have not seen it at work. I have seen both processes carried out in a small-scale Elmore plant, as described in the United States Patent No. 653,340, and also in an apparatus consisting of a section of the Elmore mixer, containing one convolution of the spiral illustrated in the drawings of the United States Patent 653,340 and in the United States Patent 676,679. I have also seen the processes carried out many times in glass cylinders and bottles, and I have myself made many tests of the Elmore processes in this way. The process, in its essential features, is as follows: Powdered ore containing metalliferous sulphides is mixed with four times its weight of water. To this pulp may be added a small percentage, say .2 per cent. to 1 per cent. of sulphuric acid. To the pulp is now added a quantity of thick viscous oil, generally thick residuum oil, the proportion of oil being from 100 per cent. to 300 per cent. on the ore by weight. The mixture is then gently rolled over and over, so as to bring the ore into contact with the oil without breaking up the oil into small globules. To a considerable extent sulphide particles adhere to the oil, and when the mixture is allowed to come to rest the body of oil floats, and the sulphide particles entrapped in the oil are buoyed up by it. The body of oil is run off from the surface of the pulp, and is introduced into a centrifugal machine, where the sulphides are extracted from the oil. Generally the tailings from a first treatment still contain a large proportion of sulphides, and these tailings are therefore treated with another body of fresh oil,
360 again amounting to from 100 to 300 per cent. of the weight of the ore.

It is essential in the Elmore processes that the oil shall be thick and viscous. I have frequently tried thin oils, such as oleic acid, in the Elmore processes, but they do not operate, as the viscosity of the oil is not sufficient to retain or entrap the metalliferous sulphides, which easily fall out of the oil. It is also essential for the same reason that the Elmore processes should be carried out in the cold, because if the oil is heated it becomes thin and will not entrap nor float the sulphide minerals. In the tests of the Elmore processes it was always essential that the mingling of the pulp and the oil should be as gentle as possible, so as to avoid the inclusion of globules of water in the oil,

and to avoid breaking up the oil into globules, because when the oil included water or when the oil was broken up, gangue was floated with the oil. I have tested the Elmore process, using vigorous agitation, and the whole pulp was brought into an emulsion like mayonnaise, full of ore, and this emulsion would not separate, after standing for months.

In the Elmore processes the flotation of the concentrate is due to the buoyancy of the oil, and the floating concentrate is a body of oil with some particles of sulphide mineral in it. This floating oil is not in any sense a froth.

The Elmore processes above referred to are matters now of only scientific curiosity. They have not been heard of in practice for many years.

361 7 Q. You have spoken of the extraction of the sulphides from the oil in a centrifugal machine. What is your knowledge as to the effectiveness of this extraction in this Elmore Bulk Oil Process?

A. In the floating material separated from the pulp there is about one part of metalliferous sulphide to two and a half or three parts of oil. After treatment in the centrifugal separator the proportion of oil is reduced to about ten per cent. on the concentrates. I have never known a case in which the proportion of oil in the concentrates was reduced below eight per cent. by this final extraction treatment.

8 Q. In Mr. Chapman's testimony, in answer to 125 X Q, wherein he describes tests of the Elmore bulk oil processes, a reference is made to a "frog's spawn effect." Will you kindly explain the meaning of this term?

A. A frog's spawn, which we frequently see in England at the margin of a pond, is a collection of little spherical eggs cohering together. In the Elmore process, if the mixture is mingled too vigorously, the oil, or part of the oil, is broken up into small globules which gather together very much in the same way as the frog's eggs do. As stated in my answer to 6 Q., it was very important in the Elmore process not to break up the oil in this way.

Adjourned to Thursday, August 29th, at 10:30 at the same place.

362 London, August 29, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Direct examination of Mr. Ballantyne continued

9 Q. Please now give consideration to such processes of ore concentration wherein the preference of oil for metallic matter was utilized, as were to some extent successful in practice up to April 12th, 1905, the date of the filing of the Provisional Specification of British Patent No. 7803 of 1905, this being the British patent corresponding to the patent in suit.

A. I have carefully investigated everything that was done in practice in the concentration of ores by oil and it has been part of my

business to know what processes were tried in practice. The first process which gave sufficient indications of practical value to justify the use in practice, was the Elmore bulk-oil process, referred to in my answers to the last three questions. This process was to some extent successful in practice, but the technical literature showed that the Elmore process had been abandoned by 1905 and as I have stated the process has not been heard of in practice for many years.

The next process of ore concentration by the use of oil which was to any extent successful in practice was the Cattermole process. I first saw tests of this process carried out by Mr. Cattermole in small bottles at the end of 1902. From that time onwards Messrs.
363 Sulman, Picard & Ballot, with various assistants, were engaged for about two and a half years experimenting with the Cattermole process described in the United States Patent No. 777,273, and exploiting the invention. Briefly stated the process is as follows: Finely crushed ore containing sulphide minerals is mixed with four times its weight of water (generally acidified) and to this is added a small quantity of oil or oily emulsion, the proportion of oil varying from forty-five pounds per ton of ore to seventy pounds per ton or more in certain cases. The mixture was agitated, first in a very violent manner so as to bring the oil into intimate contact with the sulphide particles. At this stage the oiled sulphides have agglomerated together into small flocculent masses called "flocks." Thereafter the mixture was subjected to a rolling form of agitation to cause the agglomerates to form into shotty granules. When the pulp was introduced into an upcast separator, the granules, being of great weight in relation to their area, had the power of falling readily through water, while the gangue was carried away upwards by the up-current of water, because the falling power of the gangue was not so great. The process was worked out with the greatest care and ingenuity by Messrs. Sulman, Picard & Ballot. These gentlemen erected in London a plant which has been referred to in this case as the Australian Cattermole Plant, and I frequently saw this plant in operation. To a scientific man the process was extremely
364 interesting and the agglomeration of the sulphide particles into granules is a remarkable phenomenon. My clients informed me at various times in 1904 and 1905 that the process gave a great deal of trouble to the practical man and that the consumption of oil was prohibitive on the large scale. The Cattermole process was therefore abandoned in practice.

With the exception of the Elmore process and the Cattermole process, no process of ore concentration by the use of oil had been successfully used in practice up to April 12th, 1905, so far as I have been able to determine by careful and exhaustive investigation.

10 Q. Please now relate the facts within your knowledge which led to, and culminated in, the invention of the patent in suit.

A. As I have stated, from the end of 1902, onwards I have been in constant touch with Messrs. Sulman, Picard & Ballot. Mr. Ballot's office is at 62 London Wall, London, E. C.; the laboratory of Messrs. Sulman and Picard is at 44 London Wall, E. C., and it has been my practice to attend in London Wall frequently, on an aver-

age twice a week, for the past ten years. I have also attended very frequently at the various laboratories in which these gentlemen worked, including the various laboratories or test works of Messrs. Minerals Separation Limited. The story of the origin of the agitation-froth process constituting the invention of the patent in suit, is a story of untiring zeal and industry and scientific ingenuity on the part of Messrs. Sulman, Picard and Ballot. I have had the
365 fullest possible opportunity of seeing the work of Messrs. Sulman, Picard and Ballot and I have always had the highest admiration for the manner in which, in spite of endless difficulties, they worked out the process of ore-concentration by oil until their efforts were successful and they produced the agitation-froth process which is in my opinion the greatest invention in the mineral industry in our times. The details of the origin of the invention, within my knowledge, are as follows: The efforts of Messrs. Sulman, Picard and Ballot from December, 1902, to the early part of 1905 were mainly directed to the perfection and thorough investigation of the Cattermole granulation process, but as scientific men they never shut their eyes to the possibilities of developments of ore concentration processes along similar lines to that in which they were working. Messrs. Sulman, Picard and Ballot used to confer daily on their investigations and they jointly introduced a number of modifications into the Cattermole process. In the first place they introduced the Gabbett or cone mixer which was at that time a well-known metallurgical appliance for giving a violent agitation to a liquid, or pulp, and this device was used in the Cattermole process in practice.

After trying a number of different oil emulsions and straight oils, they found that the best oil for the purpose was oleic acid, and they, therefore, carried out their later investigations with oleic acid. Messrs. Sulman, Picard and Ballot frequently discussed with
366 me the effect of heat in the Cattermole process, and during the years 1903, 1904 and 1905 the mixing of the pulp and oil was tried by them at various temperatures. Messrs. Sulman, Picard and Ballot made various other modifications in the Cattermole process.

As I have stated, there were various difficulties which arose in the investigations above referred to. Messrs. Sulman, Picard and Ballot used to refer to these as "loose end observations," and they drew my attention to them because it was their practice to keep me fully informed of all developments. In particular, I remember that on various occasions in 1903, and also in 1904, they pointed out to me an accidental flotation which they obtained in one of the upcast-separators of the Cattermole apparatus when the conditions were abnormal in some way not then understood. This accidental float consisted of loose flocculent masses of partially granulated sulphides, which, instead of sinking with the granules in the ordinary way, came to the surface of the upcast-separator owing to air attachments. The amount of this accidental float, so far as I am aware, never exceeded one or two per cent. of the total concentrate, but it was sufficient to puzzle Messrs. Sulman, Picard and Ballot, who on

several occasions asked my advice about it,' because they expressed the view that this loose end observation should be further investigated and that it might be made its own remedy, and they wished me to see that the process or processes which they investi-
367 gated were at all times properly protected by patents. Again, at various times during these years, 1903 and 1904, they pointed out to me that the degree of crushing of the ore was an important factor, particularly in practice, and it was one of the objects of the work of Messrs. Sulman, Picard and Ballot to solve the problem of successfully treating slimes, that is to say, finely crushed ore, which is so fine that it will not readily settle in water. Almost from the start another aim which Sulman, Picard and Ballot expressed to me was the reduction of the quantity of oil to be used in the Cattermole process. At the beginning of January, 1905, Messrs. Sulman and Picard informed me that they had been appointed by Messrs. Minerals Separation Ltd. to take full technical control of the experimental work of that company and to take the technical control of the test works at Aldermanbury Avenue. They expressed themselves as very pleased because they were anxious to work out to finality the process of ore concentration by the use of small quantities of oil. Mr. Ballot was then, as now, the Managing Director of Minerals Separation Limited, and during the first three or four months of 1905 investigations and discussions were taking place practically every day between Messrs. Sulman, Picard and Ballot and myself. In or about the first week of February, 1905, at a conference at 62 London Wall, these gentlemen informed me that they had decided to get to the bottom of their loose-end observations, and for that purpose they had decided to investi-
368 gate and quantify all the factors connected with the Cattermole granulation process. They informed me that they had drawn up a series of tests which they were proceeding to carry out, and they intended to have the results all plotted in curves, and we discussed the method of indicating the results. I particularly remember these gentlemen informing me at this time that they "intended to reduce the proportion of oil to a vanishing point," indeed, I believe these very words were used. At the end of February, 1905, Sulman, Picard and Ballot devised the process described in the British Patent No. 5260 of 1905, a process in which no oil is used at all, and I remember saying to them at that time (February, 1905), "you have indeed reduced the quantity of oil to a vanishing point." I only mention this to fix the dates, as this patent to which I have referred had nothing to do with the investigations of the various factors of the Cattermole process.

From the 8th of March, 1905, to the 15th of March, 1905, I saw Messrs. Sulman, Picard and Ballot nearly every day. On one of these days, I cannot fix the actual date, they informed me of their startling discovery of the agitation-froth process. To the best of my recollection, Mr. Ballot went out of town for some days thereafter, and it was not until the 31st of March, 1905, that we got together again and fully discussed the protection of the invention of the Patent in Suit. One of the first days of April, 1905, I attended

at the Aldermanbury Avenue Works with Messrs. Sulman,
369 Picard and Ballot, and they demonstrated their process to me. Broken Hill tailings crushed to 60 to 90 mesh were mixed with slightly acidified water and introduced into the ordinary Gabbett of the Cattermole test plant. 0.1 per cent. of oleic acid was added, and the whole pulp was heated to a temperature between 30 to 40° Centigrade. After violent agitation in such a way as to introduce air into the pulp, the agitation lasting for several minutes, the pulp was brought to rest and immediately a coherent and persistent froth rose to the surface. Although I was very closely familiar with all the earlier processes of ore concentration in which oil had been used, including all the prior patents which have been mentioned in this suit, the production of this agitation-froth was to me little short of a miracle. I had never seen anything of the sort before, and I recognized that Messrs. Sulman, Picard and Ballot had at last reached success in their investigations and had devised a process which would economically and successfully concentrate ores.

Summing up the above, Messrs. Sulman, Picard and Ballot first installed the cone mixer and started working along the lines of violent agitation from an early date in 1903. Secondly, they found it most advantageous to use oleic acid in their investigations. Thirdly, they found that the heating of the pulp had an influence upon the oiling of the metalliferous matter and this led them to experiment with heated pulps when going into details of
370 their final tests. Fourthly, they determined to experiment with finely crushed ore containing a high proportion of slimes and they did so. Fifthly, they determined to reduce the quantity of oil to a vanishing point and to do it step by step so as to ascertain the results obtainable throughout the range of reduction, in each case using the slimy pulp, the violent agitation, and various degrees of temperature; and using also a pulp acidified to the extent to which they were accustomed in their previous investigations.

I have seen the agitation-froth process carried out many hundreds of times. I have also seen investigations of the process making wide variations step by step in the factors which I have referred to above, and I have myself, on many occasions, carried out these investigations and I now know that if the instructions which Messrs. Sulman, Picard and Ballot drew up in February, 1905, are carried out, namely, to use a slimy pulp, acidified with say .5 per cent. of sulphuric acid, to heat the pulp say to 30° Centigrade and then to agitate it violently with proportions of oil beginning at fifty pounds of oil per ton of ore and repeating this test, reducing the quantity of oil step by step down to the vanishing point, it is inevitable that the agitation-froth shall be produced when the quantity of oil is diminished to the limits set forth in the Patent in Suit, and that a particularly good froth and efficient concentration is obtained when the proportion of oil is about 0.1 per cent on the ore, the percentage recommended in the Patent in Suit as being suitable and
371 economical. I also know that the oil selected by Messrs. Sulman, Picard and Ballot, namely oleic acid, is one of the

best and in most cases the best oil that can be used for carrying out the agitation-froth process.

Sulman, Picard and Ballot, in the later days of April, 1905, and at the beginning of May, 1905, proceeded at once and with considerable energy to reduce their invention to practice, and they continued their daily conferences at which I was frequently present. In the first week of April, they informed me that they had devised a method of making their process continuous and that they were fitting up a spitzkasten so that they could run out the agitated pulp from their cone mixer into the spitzkasten continuously and get the froth separated continuously by overflow from the spitzkasten. On several occasions at the beginning of May, 1905, I saw the process working in this way. The pulp after agitation as described in the Patent in Suit, was run out into the spitzkasten over a short launder, and when the pulp reached the comparatively still water in the spitzkasten, the thick, coherent and persistent froth rose to the surface and flowed over the lip of the spitzkasten. The process in all its essential particulars, and this separation of the characteristic agitation-froth, have remained the same to the present day, and very few weeks have passed during the past seven years in which I have not seen the process carried out in exactly this way.

372 By Mr. Scott: The entire answer is objected to upon the grounds that considerable parts of it are admittedly stated upon hearsay and it is impossible to distinguish, in view of the manner in which the answer is expressed, what if any parts of the witness's statements are based upon personal knowledge. Objection is particularly made upon the ground that the witness is giving hearsay testimony with regard to the statements preceded by the following quoted expressions: "Sulman, Picard and Ballot expressed to me," "Messrs. Sulman and Picard informed me." "They expressed themselves," "These gentlemen informed me," "They informed me," "I particularly remember these gentlemen informing me at the time that they."

By Mr. Williams: It is submitted that these statements of the inventors in regard to their plans and procedure are relevant, competent and material on the issue of inventorship raised by the Defendant.

11 Q. Please now relate the facts within your knowledge as to the preparation of the patent applications in Great Britain, United States, and other countries for the invention set forth in the Patent in Suit.

A. On the first Sunday in April, 1905, I made at home a rough draft in pencil of a provisional specification upon the inven-
373 tion of the Patent in Suit. I had it typed out the following day and took it down to Messrs. Sulman, Picard and Ballot, and we discussed it, various additions and alterations being made during our conference. There were various re-drafts of the specification which went to and fro between Messrs. Sulman, Picard and Ballot, and my firm in the early days of April, 1905, and on the 12th day of April, 1905, the application for a British Patent was lodged accompanied by the provisional specification. Upon the first of May, 1905, or thereabouts, Messrs. Sulman, Picard and Ballot, in-

structed me to prepare a complete specification and drawings for filing in the United States and other foreign countries. I again proceeded to Aldermanbury Avenue Test Works with my firm's chief draughtsman, Mr. G. C. Walker, who took sketches of the apparatus. Mr. Sulman supplied me with a rough sketch or diagram of the complete apparatus similar to the diagram referred to in this case as "Sulman Drawing accompanying Report May 3, 1905." I then proceeded to draft the complete specification with reference to the drawings prepared by Mr. Walker and I also prepared claims for the United States and other foreign patent applications. These were again discussed in detail with Messrs. Sulman, Picard and Ballot, and when the American papers were completed my firm dispatched them to the United States on the 20th of May, 1905.

12 Q. You have said that on one of the first days of April,
374 1905, you attended a demonstration of the agitation-froth process at the Aldermanbury Avenue Works. Who were present at the demonstration and by whom was the actual manipulation carried on?

A. There were present the three inventors, Messrs. Sulman, Picard and Ballot, Mr. John Leechman and Mr. Arthur Howard Higgins, two of their assistants, my partner, Mr. Harold Wade and myself. The actual manipulation was carried on by Mr. Sulman, Mr. Leechman and Mr. Higgins.

13 Q. Please state whether or not on this occasion the question of patenting the invention was discussed in the presence of Mr. Leechman and Mr. Higgins?

A. The object of the visit of Mr. Wade and myself was to obtain the necessary particulars for the patent application and the patenting of the invention was discussed fully in the presence of all the gentlemen above mentioned during the demonstration.

14 Q. Were any of the particulars of the invention given to you verbally or otherwise by Mr. A. Howard Higgins?

A. Mr. Higgins did not give me any information verbally, but before the patent application was prepared I asked for all the particulars of tests made, with the object of defining the limits of the invention, and among the other information supplied to me were the two reports of Mr. Higgins which have been referred to in this case as "Higgins' Report, March 2, 1905," and "Higgins' Report, March 16, 1905."

15 Q. In the apparatus employed for this demonstration to
375 you of the agitation-froth invention were there baffles within the agitation-vessel?

A. Yes.

16 Q. Please describe the construction of these baffles as you remember them.

A. The baffles consisted of three loops of wire depending from a ring of wire. This ring was slipped over the top of the cylindrical glass vessel so that the loops of wire dipped down into the pulp at the sides of the rotating cone.

17 Q. Are these baffles shown in Figure 1 of the Patent in Suit?

A. No.

18 Q. How do you account for the fact that they are not shown in Figure 1 of the Patent in Suit?

A. Figure 1 of the Patent in Suit is merely a diagram illustrative of the type of apparatus suitable for carrying out the invention. At the time when my firm's draughtsman made his sketch the apparatus was not in use and the baffles were not placed in position. When I saw the drawing prepared for the specification I made no alteration on it because it was a mere diagram and because the indication of a vessel with a cone rotatable on a vertical axis in the vessel was a sufficient indication to a metallurgist that a Gabbett or cone mixer was to be used. I notice that the drawings which I employed in the Cattermole specifications embodied the same convention as does the "Sulman Drawing Accompanying Report May 3, 1905."

376 Indeed I state as a fact that in the years 1900 to 1905 it was common to indicate a Gabbett or cone mixer by a sketch of a vessel with a cone in it. I also point out that Figure 1 of the Patent in Suit is a mere diagram in every other respect. The pump R is of the conventional form generally introduced in patent drawings. I have never seen such a pump in use in the agitation-froth plant. Again the swan-neck pipe H is bent round in such a way as to make the diagram fit into a single sheet of U. S. Patent Office drawing paper. As a matter of fact in the actual apparatus the pulp passed straight on from a short swan-neck pipe to the spitzkasten somewhat as shown in the "Sulman Drawing Accompanying Report May 3, 1905." Again there were three mixers in the actual plant but we did not have room for three in the diagram. Again we had no room in the diagram for the shaking table and in other respects the diagram does not give a picture of the actual apparatus. In my opinion the process is so simple that a metallurgist requires no drawing to enable him to carry the process into effect, but I inserted a diagram in the complete specifications describing the agitation-froth process as I think that a diagram assists the reader in appreciating the invention.

19 Q. In what countries was the diagram of Figure 1 of the Patent in Suit filed as a diagram "illustrating one form of apparatus suitable for carrying this invention into practice." I have quoted from the specification of the Patent in Suit, page 2, lines 47-49.

377 A. The diagram was used for this purpose in the following countries: Great Britain, France, Italy, Hungary, Norway, Sweden, Natal, Canada, Mexico, Australia, Russia, Argentine Republic, Belgium, Spain, Austria, India, Transvaal, Rhodesia, Cape Colony, New Zealand, Cuba, Germany, Chili, Bolivia and Peru, and of course in the United States.

20 Q. Does the word "Gabbett" appear in any of the specifications filed in any of the Patent Offices, and have you recently refreshed your recollections as to this point by an examination of the public record thereof, and what does this public record show and what are the particulars relative to this fact?

A. I have refreshed my memory on this point recently by examining the original provisional specification filed at the British Patent Office, but I also recollect the circumstances clearly. In the specifi-

cation which I originally prepared and filed in Great Britain I described the mixers as "Gabbett mixers." The provisional specification was examined in April, 1905, by Mr. Examiner Graves, who is now the Commissioner of Patents for the Empire of India. Mr. Graves was a metallurgist. He pointed out to me that the word "Gabbett" being the name of a patentee ought not properly to be used in a British Patent specification, and he asked me to alter the term "Gabbett mixer" to the equivalent well-known term "cone mixer." Mr. Graves' proposal was obviously sensible and I adopted it. The body of the specification for the United States Ap-
378 plication and those in other foreign countries was largely copied from the British Patent specification.

21 Q. Referring now to Figure 2 of the Patent in Suit please state whether or not in the cone mixer there shown there is an illustration of an effective baffle?

A. There were in the Minerals Separation laboratory several mixers of the type shown in Figure 2 of the Patent in Suit. The discharge conduit *a* provided an effective baffle, and the usual removable wire baffles were dispensed with when this type of mixer was employed.

22 Q. Please now give consideration to such proposed processes of ore concentration by oil as were described in Patents or other publications prior to April 12, 1905, and known to you, and which were not included in your answer to 9 Q., which was limited to those processes which have been utilized to some extent in the art?

A. Mr. Ballot called my attention some six years ago to a curious passage in Herodotus in which a wonderful story was told of the virgins in a strange and mythical island, who smeared pitch on feathers and rubbed the feathers in the sand at the bottom of a lake whereby particles of gold in the sand stuck to the pitch and were thus collected.

In the year 1903 I made an exhaustive investigation of the whole subject of ore concentration with the object of tracing any references on paper to the use of oil in ore concentration, and I dug up
379 from obscurity a number of documents, many of which have been referred to in this case. The first of these was the British patent of Haynes No. 488 dated 23d February, 1860. This describes a process for obtaining metals from their ores, which consists in mixing the ore (ground to 100 mesh) with oily or fatty matter and bituminous or tarry matter so as to form an admixture of the agent and the ore. The admixture which is in the form of a stiff paste is then kneaded in water with the object of washing out the gangue. I have frequently tried to work this process and unquestionably some gangue can be washed out of the pasty mass, but any such process is entirely impracticable, and the process never could have been of any use, but it is an interesting scientific curiosity.

The next patent specification which contains proposals for the treatment of ores by the use of oil is the United States Patent of Everson No. 348,157 of 1886. Two processes are described and I have frequently experimented with both of these processes. Everson's processes are of the same type as the Haynes process, that is

to say the powdered ore in a dry state is made into a paste or mud with oil or fatty matter and thereafter this paste is kneaded under water with the object of washing out the gangue. Everson's process differs from Haynes' process in that the water is acidified, for example to the extent of one or two fluid drachms of acid to one gallon of water, i. e. rather less than 0.2 per cent. on the water. The first process described in Everson's specification is so complicated
380 that it can be set aside because no one would ever think of carrying it out in practice. Referring to the second process, which is described in the patent specification No. 348,157 from page 2, line 75, to page 3, line 64, the powdered ore is mixed with petroleum or paraffine oil. The proportion is defined in two ways; first as three fluid drachms of oil to two ounces of ore. Three fluid drachms equal 180 grains. Two ounces of ore equals 900 grains. Therefore the proportion of oil to ore is 20 per cent. Again the proportion is stated to be a barrel of oil to a ton of ore. An American barrel in 1885 was, I am informed, 500 pounds, while a ton was 2,000 pounds, so that the proportion of oil to ore was 25 per cent. In testing the Everson process I mixed the powdered ore with the oil thoroughly; I then placed the mass in water acidified as above stated. I then agitated the mass so as to detach the sand as far as possible and attempted to remove the concentrate by means of a constant overflow of water from a washing-out vessel. Sometimes I got practically nothing to overflow, but in many cases I succeeded in getting the oil with some sulphides in it to flow off with the water overflow. Everson found, as is the fact in many cases, that the sand is heavier than the mixture of mineral and oil and I have seen cases in which the oil floated quite a fair proportion of the sulphide minerals in the vessel used for washing out. This process like the process of Haynes is curious and interesting to a scientist. I am certain that the process could not be carried out in practice with any
381 measure of success; and the specification is only of importance as showing the origin of the remarkable fact that acidified water has a greater wetting power for gangue than neutral water.

The next patent specification relating to a process of concentrating ores in which oil is mentioned is the United States patent of Hebron and Everson No. 471,174 dated 22d March, 1892. I have never attempted to carry out the proposals contained in this document. It is suggested that buoyant material such as bark, moss, straw, cotton-wool, soap, and so forth, shall be "pressed into the cavities and pores of the mineral particles" so that they (the joined mineral and metallic particles of the ore and buoyant material) are of less specific gravity for the time than the rock particles of such ore. Bearing in mind the nature of a powdered ore this suggestion is perfectly absurd. No intelligible process is described in the patent specification.

Another patent specification relating to the same proposal is United States Patent of Hebron 474,829, dated May 17, 1892. This process is stated to be an improvement on the process heretofore invented by Carrie J. Everson and myself jointly" followed by a specific reference to the application for the patent which I have just described. This specification describes an apparatus and a process

and is characterized by the fact that there is no reference to the use of oil or soap whatsoever, but the buoyant material to be used is to be approximately equivalent in bulk to the bulk of the min-
382 eral and is to be applied to the powdered ore in a dry state whereby the buoyant material "is forced into the openings or interstices existing between the atoms constituting the porous, metallic and mineral particles."

The next oil process of ore concentration is that of Robson and Crowder described in U. S. Patent No. 575,669. In this case the powdered ore mixed with twenty-five to thirty-five per cent. of water is brought into intimate contact with an oily liquid that is of less specific gravity than water and is capable of taking up the finely divided metallic matter and thus separating it from the substance with which it was previously mixed. The process is the converse of the Haynes and Everson processes. Instead of washing out the gangue from any oily mass with water, Robson and Crowder try to wash out the sulphides from a watery ore paste by the means of a stream of oil. I have tried the process. It is of no use.

It is at this stage that the Elmore bulk-oil flotation processes appear.

In July, 1902, I learned of the Scammel process which was a modification of the Elmore process in which the oil was treated with sulphur chloride. Mr. Scammel was a client of my firm and I patented the process which was taken up by another client of my firm, Mr. Wolf. We introduced Messrs. Scammel and Wolf to Messrs. Sulman and Picard, who made a vigorous attempt to carry the process into effect, but without success.

I have already referred to the Cattermole process which
383 appeared in November, 1902. In July, 1903, Messrs. Sulman and Picard invented the process which has been referred to in this case as the "Bubbles" process, and I prepared several different patent specifications on this process and filed these at the British Patent Office, in July, 1903, and in the following months.

The first process to which Messrs. Sulman and Picard directed my attention in this connection was as follows:

An ore pulp was agitated with oil as in the Cattermole process so as to produce not shotty granules but flocculent masses or "flocks" of oily sulphides. Indeed in the tests which I saw I believe the tailings from the Cattermole process were used because these contained such oily flocks. Some powdered calcite was introduced into this pulp and sulphuric acid was added to the pulp, whereupon bubbles of carbonic acid gas rose to the surface of the pulp, and these bubbles showed a tendency to adhere to the oily flocks of mineral and to buoy them up to the surface. Messrs. Sulman and Picard said that they had here indications of a method of separating oiled sulphides from gangue by the attachment of gaseous bubbles to these oiled sulphides, and this idea was embodied in the provisional specifications to which I have referred. Another test that Messrs. Sulman and Picard showed to me was one in which these Cattermole tailings with oily flocks of mineral in them, were introduced into a glass vessel con-

384 taining a glass worm with minute perforations in it. This worm was slowly turned round in the vessel and air was blown in through the worm, so that minute bubbles of air rose up through the pulp. Here again there was a distinct tendency for bubbles of air to attach themselves to the flocks and bear them up to the surface. In August, 1903, we came across an abridgement of Froment's British Patent No. 12,778 of 1902, in the "Journal of the Society of Chemical Industry," and I advised my clients that Froment had anticipated this idea of floating oily flocks of mineral by bubbles of gas chemically generated in the pulp. Mr. Ballot asked me to open up negotiations for the purpose of Froment's patent rights. I communicated with Mr. Zanardo, our agent in Rome, who was also Mr. Froment's Patent Agent, and obtained an option on Mr. Froment's patent rights. In due course I received a description by Mr. Froment referred to in this case as "Froment's Description," and my firm's translator translated this description into English. I am familiar with the French language. I read the translation and checked it with the original, making one or two alterations, and I now produce this translation.

My clients made heroic efforts to get some sort of practical result from the Sulman and Picard bubbles process, or from the Froment process, but without success. I myself made a number of tests on these processes, and in connection with this suit and various other proceedings during the past five or six years I have frequently

385 tried to work these processes. In a laboratory where one can nurse the small quantities of materials dealt with, it is sometimes possible to get indications of a separation of oily flocks of mineral by the Froment process or by the Sulman and Picard bubbles process described in the United States Patent No. 793,808, and, in 1903, the results were sufficiently promising to justify my clients in applying for patents, but nothing practical could be made of these processes. Even if they had been of any use I can see that they would have been replaced by the agitation-froth process, which in every respect is a more practical, economic and efficient process of concentrating ores. In this connection I should also add that on no occasion when these bubbles processes were shown to me were the oily flocks recovered in anything that could be described as a froth.

Also, in 1903, Sulman & Picard invented the process of skin flotation of oiled metalliferous minerals. This process was also shown to me as applied to the tailings from the Cattermole process, and the oily flocks were separated from the gangue by bringing the pulp through air on to the surface of the water, whereby some of the oily flocks floated off by the surface tension effect while the gangue sank. Later on Messrs. Sulman, Picard and Ballot jointly worked out this process to a great extent, and invented the process described in the United States Patent No. 879,985. This invention is dependent on the Skin Flotation of oiled metalliferous matter.

386 The phenomenon is entirely distinct from the phenomenon of the agitation-froth. Separations of oiled metalliferous matter from gangue can be obtained by the process described in United States Patent No. 879,985, but the process does not compare with the agitation froth process in economy or efficiency.

Reference has been made to the "Soap" process of Cattermole, Sulman and Picard, described in United States Patents Nos. 777,274 and 788,247. The origin of these patents is as follows: These gentlemen found that when ordinary oleic soap (sodium oleate) was used instead of oil in the Cattermole process, the sulphuric acid in the pulp decomposed the soap, liberating oleic acid throughout the pulp. This proved to be, and is, a convenient way of distributing oleic acid throughout a pulp. The invention was described in the British Patent No. 17,109 of 1903, and when a corresponding application was lodged in the United States, it had to be divided into the two Patent Applications referred to, one of which includes the use of the soap reaction in the Cattermole process, and the other of which includes the use of the soap reaction in the Froment process. As a matter of fact, I have never seen the soap reaction used in the Froment process.

The Schwarz process, described in the United States Patents No. 807,501 and 807,503 was brought to me by Mr. Schwarz some little time after the application for the patent in suit. His process closely resembles Haynes' process in that the powdered ore is first
387 mixed with a mixture of oily matter and fatty matter, so as to make a thick, pasty mass, after which an attempt is made to wash the gangue out of the mass with water. I have tried processes of this type many times, and I know they are quite useless.

For the sake of completeness, I may say that I have read the United States Patent Specifications of Kirby, Nos. 809,959 and 838,626, and I have tried to reproduce the processes therein described, but the process is of no use, and, as in the case of the Elmore process, the amount of oil necessary is prohibitive. A number of patents have been taken out for the concentration of graphite ores by the use of oil. Among these are the U. S. specifications of Glogner, No. 736,381, Good, No. 745,960, and Kendall, No. 771,075. These processes depend upon the same phenomenon as the Elmore process, but in so far as graphite is very easily floated by oil, a smaller quantity of oil can be used with graphite than with metallic sulphides. I have seen the agitation-froth process applied to a graphite ore with extraordinary good results, but I have never tried any of these earlier bulk-oil methods on graphite ores. Indeed, the expense of all bulk oil methods would prohibit their use in the treatment of graphite ores where the margin of profit is, of course, much lower than with valuable minerals like zinc, lead and copper.

Adjourned to Friday, August 30th, 1912, at 10.30 A. M., at the same place.

388 London, August 30th, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination of Mr. Ballantyne continued:

23 Q. Now, please give consideration to processes of ore concentration in which oil is not employed, such as are described in patents prior to April 12, 1905, and familiar to you?

A. The first process of this type was that described in Bradford's U. S. Patent No. 345,951. In this process powdered ore in water is drained so that the particles are exposed to atmospheric air, after which they are caused to meet the edge or surface of a still body of water, whereupon certain particles float off on the surface of the water, and are thereby separated from other particles which sink in the water. At the end of 1904, and at the beginning of 1905, Messrs. Sulman, Picard and Ballot without knowing of Bradford's process, worked out a process on the same lines, which is described in British Patent No. 5,260 of 1905, which patent is now abandoned. This process, which was briefly described, as skin flotation without oil, was given a very thorough trial in 1905, 1906, and the early part of 1907, because in so far as the process involved the use of no oil or other agents, an economy in this direction might have been effected if the process had been a success. However, it is only
389 very rarely that an ore will give anything like a reasonable separation by such a method. The process is not applicable to slimes, and as the floating particles are in the form of a film, or in patches one particle thick, the area of the separating surface has to be very large, and there is great difficulty in keeping it sufficiently still to allow of any skin flotation. Unfortunately also some gangue materials are floated by skin flotation as readily as associated mineral. My clients spent large sums of money in trying to get some useful results from this skin flotation process without oil, but without avail. The Bradford patent was brought forward by the United States Patent Office against an application for a patent corresponding to the British Patent No. 5,260 of 1905, and the United States application was therefore abandoned.

The next non-oil flotation process for the concentration of ores is that of Potter described in the United States Patent No. 776,145. In this process an ore, after being powdered or pulverized, is placed in a vat or vessel, and a solution is then added consisting of water with the addition of from one per cent. to ten per cent. of sulphuric acid, generally two and a half per cent. of sulphuric acid. Heat is applied to the vat to bring the temperature of the pulp in practice up to about 85° Centigrade, that is, a little short of boiling point. The effect of the acidulated solution becomes apparent by the bubbling up and gathering on the surface of the fluid of the metallic concentrates in the form of a pasty mass. I have tried this process
390 frequently. It is a process which is only capable of use in a very few instances where it just happens that at this high temperature, carbon dioxide gas is evolved from the ore in such a way as to attach itself to the sulphide particles and bring them up to the surface.

The next process of the same class is that of Delprat described in the United States Patents No. 735,071 and No. 768,035. The process is dependent on the same factors as the Potter process. The finely ground ore is introduced into a bath or solution either of nitric acid or acid sodium sulphate (a saturated solution). In practice the solution was heated to a temperature very little short of boiling. Gaseous bubbles are generated chemically from the ore, and attaching them-

selves to the sulphides, carry them to the surface. Here, again, the process is only applicable in certain specific cases.

In both the Potter process and the Delprat process it is important that the pulp should not be in a state of turbulence and that the powdered ore should not be stirred up into the pulp. The powdered ore immersed in the hot acid solution is gently turned over so as to allow the particles with adhering gas bubbles to rise to the surface.

24 Q. Please now give brief consideration to the Patents to Hockley, 466,753, Rouse, 469,599, Stoveken, 729,805, Wagner, 373,113 and Wolf, 787,814, which have been referred to by the defendant and not included in your preceding answers?

391 A. Hockley's U. S. Patent 466,753 discloses an "ore slimer." Hockley's is not a process for concentrating ore, but a method of saving the lighter suspended matter in slimy water containing valuable slime particles, such as gold slimes. The pulp is obviously one from which the bulk of the metallic matter has already been removed. It consists of water containing worthless gangue and valuable slimes. Hockley uses no oil or anything of that sort, and does not mechanically agitate the pulp. Hockley merely bubbles air, water or steam through slime pulp so as to cause an upward current to carry the flour gold upwards and away. The reason for this is that the particles of flour gold are so small that they will not sink in water and are readily carried upwards by an up-current. There is no selective adhesion of gaseous bubbles to mineral particles and there is no froth formation. Indeed, there is no real flotation in Hockley's method. The flour gold is in suspension in water, and flour gold having a great area in comparison with its weight, is easily carried away in a current. The air, steam or water is only used to create such a current. The mineral particles are not oil-coated, nor are they attached to air bubbles, nor are they floated to the surface to form a froth. So far as I can see, the specification of Hockley is of no interest in the subject under consideration.

Rouse, in United States Patent No. 469,599, is not dealing with ores, and his process is not a process of concentration. Rouse aims at separating slime or fines from the water used in milling

392 ores. In milling an ore, a good deal of slime is formed and it will not settle in water. Before anything can be done with the suspended matter, it must be removed from the water, and Rouse's object is merely to get the very finely divided solid matter out of the water. The essence of Rouse's process can be seen from page 1, lines 94 to 96, where it is stated that:

"The constant upward circulation of air through the slime water tends to elevate all foreign matter to the surface of the water and to create or form a mass of strong foam having a great carrying energy for matter foreign to water."

Stoveken's United States specification 729,805 describes and illustrates an apparatus for use in the cyanide process, and Figures 2 and 3 show the agitation tank. I have personally not seen this specification prior to this suit. I have tried the agitation-froth process many times and I have used various types of apparatus for agitating and aerating the pulp as set forth in the patent in suit. I think that if

the Stoveken apparatus could be rotated at a sufficiently high speed it might be used in the agitation-stage of the agitation-froth process, but I have never seen a Stoveken apparatus, and I do not know whether it has ever been used even in the cyanide process, which is, of course, a process for dissolving gold by chemical action, and not a process for ore concentration.

393 Wagner's United States Patent No. 373,113 describes a churn. The essential feature of the invention is the use of suspended dashers operated to revolve in reverse directions upon nearly vertical shafts. The dashers consist of spiral blades intercalating with one another. I have never seen Wagner's specification before to-day, and have never heard of the Wagner churn being made or used. I take it that it is suggested that a churn of this type could be utilized at the agitation-stage of the agitation-froth process, and, provided the apparatus was furnished with suitable inlets and outlets, and provided it could be operated at a speed sufficiently high to bring a microscopic quantity of oil into intimate contact with the metalliferous particles in an ore pulp and to introduce air into the pulp as described in the patent in suit, I have no doubt the apparatus could be used in the agitation stage of the agitation-froth process, but I have not tried it.

Wolf's United States Patent No. 787,814 refers to the use of an agitator lettered B in the drawings. I personally made this drawing, or the sketch from which it was reproduced. The agitator was obtained by Messrs. Sulman & Picard from Mr. S. H. Johnson of Stratford, London, E. An agitator of this type is capable, when rapidly rotated, of giving the same type of mixing and aeration as the Gabbett or cone mixer. In the Wolf process the object was to agitate a large body of oil with the ore pulp so as to break up the oil into small globules, purposely to produce what we have referred

394 to as "the frog's spawn effect." This mass of oil-globules entrapped a large proportion of mineral and also a large proportion of gangue and the oil was run off and introduced into vessels containing hot water where the oil-globules rose to the surface and it was intended that the hot water should cause the oil to drop the gangue. The experiments in this direction which I saw were nugatory Under the conditions of this process no froth was produced, but simply a large body of oil all broken up into small globules and containing a lot of ore.

25 Q. In your answer to Question 22 you produced a translation of the Froment description and mentioned the fact that this description had been received by you. I note that the translation also includes the descriptive matter on the Froment drawings which have been marked "Froment Plan" and "Froment Drawing A." Please state whether or not this is a correct translation, as well of the descriptive matter on the drawing as of the text or description?

A. It is, and I may add that the Froment drawings were received in my office at the same time as the description, marked "Froment Description" was received.

By Mr. Williams: The document marked for identification "Froment Description" is offered in evidence as "Complainants' Exhibit Froment Description."

The drawings marked for identification "Froment Plan"
395 and "Froment Drawing A" are offered in evidence with corresponding titles.

The translation produced by the witness and described in the last answer is offered in evidence and marked "Complainants' Exhibit Translation of Froment Description and Descriptive Matter on Froment Drawings."

The drawing marked for identification "Sulman Drawing Accompanying Report May 3, 1905," is offered in evidence with a corresponding title.

26 Q. You have stated that it has been your practice to frequently visit the various works' laboratories of Minerals Separation during the past years. It has been suggested that in the large plant at the Charlotte Street laboratory the floating material obtained in the spitzkasten was in the form of a film instead of a froth. What have you yourself seen in the operations at that laboratory in corroboration or contradiction of this suggestion?

A. I cannot corroborate this suggestion. On the other hand I frequently saw the large plant at Charlotte Street in operation and saw, what one always sees in the agitation-froth plant in operation, namely, a thick coherent and persistent froth floating over the body of liquid in the spitz boxes. I recollect that on one occasion at Charlotte Street Mr. John Leechman, who on that day was running the plant, picked up an ordinary shovel or spade with a heavy
396 iron blade and put it on the froth, which was not broken, but supported the spade along the surface of the spitz box. This has to be seen to be believed.

27 Q. What in general is the law of Great Britain as to the patenting of inventions so far as relates to the requirement of inventorship in the applicant, and specifically what has been your advice to your clients, Minerals Separation Limited and predecessors including Messrs. Sulman, Picard and Ballot, as to this point, and what has been the practice of these clients in this matter?

By Mr. Scott: That part of the question which seeks to elicit the advice given by the witness is objected to as incompetent, irrelevant and immaterial inasmuch as the issue involving the point whether the patentees are joint and original inventors is an issue of fact and the application of the law thereto which issue can in no way be affected by the testimony called for. That part of the question relating to "the practice of these clients in this matter" is objected to as calling for mere conclusions or opinions upon a matter which can only be determined by the Court from the facts properly in evidence.

A. Any person may make an application for a British Patent provided that he is the true and first inventor, or applies jointly with the true and first inventor or inventors, or has received the

397 invention from abroad. Two or more persons may make application for a British Patent, and a patent may be granted to several persons jointly, some or one of whom only are or is the true and first inventors or inventor. The application must be accompanied by a declaration (equivalent in England to an affidavit) stating, in the case of a joint application, which of the applicants are or is the true and first inventors or inventor. In other words the application may be made by the actual inventor or inventors, together with others, but the application form must state which of the applicants made the invention.

With regard to British Patent applications I have advised Messrs. Minerals Separation Limited and their predecessors to make applications in the names of the actual inventors or inventor, although in some cases the name of the Company has been added according to a common British practice. It is more convenient under the terms of the International Convention to make the application of origin, namely the British application, in the actual inventors' names, because in certain other countries and colonies it is compulsory that the applications shall be made in the names of the true and first inventors only.

I have been familiar with the American Patent Law since 1901, and a large part of the work of my firm involves the procuring of American patents. When I received instructions to apply for an American patent I always made it particularly clear that the
398 application must be made by the actual and original inventor or inventors.

I have particularly brought this to the attention of Minerals Separation Limited and their predecessors when I have been instructed to make applications for American patents for them. I clearly recollect prior to the application for the Patent in Suit, taking steps to ensure that the application should be in the names of the actual inventors.

An examination at the British Patent Office of the records of the Patent Application in which Minerals Separation Limited are interested shows that the applications have been made in the names of the true and first inventors who have declared themselves so to be, and that in a few instances the corporation Minerals Separation Limited has been joined as an applicant, and of course specifically excluded from the declaration of inventorship, and that in a few other instances where the true and original inventors were abroad and it was necessary to file the application without delay, the applications have been filed either by the corporation or by some member of my firm as the applicant, naming the true and original inventor or inventors as the communicator or communicators.

28 Q. Have you read the testimony which has been taken in this suit?

A. I have.

29 Q. In your investigations of the literature of metallurgy
399 and of patents relating to metallurgy and your experience in metallurgy have you *even* encountered any process of ore concentration prior to the agitation-froth process or referred to in

any of the documents in this case, other than the agitation-froth process, in which an ore pulp was violently agitated and flowed into a spitz box and in the spitz box a froth floated on the surface of the liquid?

A. No.

30 Q. Referring now to the apparatus which has been described in the evidence in the depositions of Edward H. Nutter, Jesse C. Gibson and James M. Hyde and which has been generally identified as defendant's experimental plant, could this apparatus be used for any of the prior processes or other processes referred to in the last question except the agitation-froth process so as to produce a floating froth in the spitz boxes of the type described by Mr. Nutter in his deposition?

A. No.

31 Q. Assuming that powdered ore, water acidified with sulphuric acid, and oleic acid, are fed into the defendant's apparatus referred to in the last question, what have you to say as to what would happen?

A. Firstly, if this operation were performed so as to produce a floating froth of concentrates in the spitz boxes, the operation could only be consistent with the use of the agitation-froth process as described in the Patent in Suit. Secondly, if the amount of oleic acid used were too low to produce the agitation-froth, it is obvious
400 that the froth would not be produced. Thirdly, if the amount of oleic acid were in excess of that necessary to produce the agitation froth in the most efficient and economical way, part of the sulphide contents of the ore would be agglomerated into little flocks which would sink in the spitz box and the froth would no longer be a good and efficient froth.

32 Q. Now, referring to defendant's second plant as described in the deposition of Eugene A. Byrnes, would you in any way modify your answers to 30 and 31 Q. in relation to this apparatus?

A. No.

33 Q. What have you to say as to the suggestion that the re-treatment of concentrates and of the residues obtained from the re-treatment of concentrates, constitute either separately or collectively, a departure from or an improvement on the agitation-froth process as set forth in the Patent in Suit?

A. The concentration of an ore or like product is an operation involving the treatment of the ore with the object of increasing the proportion of the valuable constituents in relation to the worthless constituents or gangue, and is carried out either by removing from the ore a portion which consists mainly of gangue, in which case the remaining ore is enriched; or by removing from the ore a part in which the proportion of valuable constituents is higher than in the original ore. It is an axiom in ore dressing that so long as it pays to enrich a product by concentration, the treatments above
401 referred to should be continued or repeated and it is thus everyday practice to re-treat tailings or middlings containing values, for the extraction of the values therefrom, or to re-treat concentrates to improve the grade thereof, and this axiom applies to

concentrates, middlings and tailings at any stage in ore-dressing operations.

I say that in the agitation-froth process the re-treatment of the tailings or of the concentrates or of the tailings from retreatment of the concentrates, either separately or collectively, does not constitute a departure from or an improvement on the agitation-froth process as set forth in the Patent in Suit, and such operations of re-treatment would not in any case be of an inventive character.

As a matter of fact in the tests carried out in the Minerals Separation Works and Laboratories, it has been common practice for years back to re-treat either tailings or concentrates, and indeed in the Patent in Suit the further treatment of the tailings is referred to.

In the year 1910 and in the early part of 1911, Minerals Separation had plants erected specially for the purpose of producing a dirty concentrate by the agitation-froth process and of retreating this concentrate again by the agitation-froth process. The plant and one of the processes carried out in it had novel features which formed the subject of patents in 1910, but although re-treatment was used I inserted in the Patent Applications no claims thereto because I knew that these re-treatments were matters of daily
402 practice and common knowledge among those accustomed to the use of the agitation-froth process.

The numbers of these Patents are Nos. 23870/1910 and 23949/1910, both British Patents. The first Patent No. 23870/1910 covering a process of differential flotation, and the second patent No. 23949/1910 covering an apparatus known as the "Froth Trap" Apparatus, and the process carried out in each case is the agitation-froth process.

Direct examination closed.

Cross-examination.

By Mr. Scott:

34 X Q. What was the Gabbett used for, that is what particular operations was it used for, prior to 1905?

A. Agitating or mixing any liquid or semi-liquid.

35 X Q. Do you know of any particular industrial operation in which it was so used?

A. The only time I have seen it in use was in the laboratories of Sulman & Picard and of Minerals Separation Limited.

36 X Q. Have you any other knowledge of any other specific instance of its use?

A. Not personally.

37 X Q. Was the Gabbett which you saw in Sulman, Picard and Ballot's laboratories the first one you have ever seen?

A. The first actual machine.

38 X Q. Upon what occasion did you first see part of the
403 constituents of an ore floating upon the surface of a liquid in the form of a scum or froth?

A. On one of the first days of April, 1905.

39 X Q. As the Cattermole process for causing granulation and precipitation of the valuable parts of an ore has been described there are two stages of agitation, one carried out in a cone mixer having baffles and the other carried out in a cone mixer, cylindrical in form, and having no baffles. I presume there is quite a marked difference between the effect caused by the use of the cone mixer with baffles as distinguished from its use without baffles. Is that correct?

A. I think the agitation in a cone mixer from which the usual baffles have been removed is much less violent than in an ordinary cone mixer.

40 X Q. And this less violent agitation which takes place without the baffles is an important feature of the Cattermole process, is it not?

A. I should not like to say anything about its relative importance. The granulation phenomenon is chiefly a function of the proportion of oil added to the ore pulp. In the first investigation of the Cattermole process, that is in Mr. Cattermole's own tests, the experiments were done in bottles. It was Sulman, Picard and Ballot who introduced the cone mixer and one or other of these gentlemen tried to make the Cattermole granules more shotty by gentle rolling agitation, and one of the ways in which they did this was to use an ordinary cone mixer from which the baffles had been removed
404 and in which the cone was rotated at a very much lower speed than was necessary for bringing the oil into efficient contact with all the mineral particles in the pulp, as in the actual cone mixer used at the commencement of the Cattermole process.

41 X Q. The effect of rolling the pulp in a cone mixer without baffles was considered a superior way of carrying out the Cattermole process, was it not?

A. In 1903, I merely saw what was done. It is a fact that a gentle rolling agitation of the oily agglomerates did make them more shotty and therefore more easily separable in the upcast classifier, and it is also a fact that Sulman Picard and Ballot used a cone mixer from which the ordinary baffles had been removed, and rotated it at a slow speed so as to give a gentle rolling agitation with the object of rendering the granules more shotty at the end of the Cattermole process.

42 X Q. Do you find this two stage agitation in any way referred to in the Cattermole United States Patent 777,273?

A. Yes. The agitation described with reference to the drawings was carried out in ordinary Gabbetts, but it is stated on page 3, lines 46-50, that "with certain ores it may be preferable to use in some "stages of the process a rolling form of agitation, as in cylinders or "barrels, to obtain good granulation of the mineral."

43 X Q. Do you find anything in the drawing of Cattermole United States Patent 777,273 and the description thereof stating or implying that the agitation is to be of two kinds, one in the
405 cone mixer with baffles and one in the cone mixer without baffles?

A. No, and I think that at the time when I prepared this specification a cylinder was being used or experimented with for the purpose of producing more shotty granules when this was necessary.

44 X Q. But long before the Spring of 1905, when the application

for the Patent in Suit was prepared, the cone mixer without baffles had been in use, had it not?

A. Not for the purpose of bringing a small quantity of oil into efficient contact with all the mineral particles in an ore pulp, but it had been in use for at least a year for imparting a gentle rolling motion found suitable for converting, what I may call loose granules into shotty granules in the final stages of the Cattermole process.

45 X Q. Evidently you have used the same conventional drawing to represent cone mixers with baffles and without baffles. In putting the question in this form I refer to your testimony regarding the drawing of the patent in suit?

A. I do not recollect ever having indicated in any patent specification a cone mixer which was to have no baffle.

46 X Q. How would you indicate one that had no baffle except by showing it without baffles?

A. If I wished to describe an apparatus which agitated an ore pulp and a small quantity of oil in such a way as to bring
406 the oil into intimate contact with the mineral particles of the ore, I should indicate this by stating it in the body of the patent specification. If I wished to indicate the use of a cone mixer I should use the convention which I have used. If I wished to indicate that the agitation or turbulence was to be diminished or minimized in any way, as by leaving out the usual baffles of the cone mixer, I should make a statement to that effect in the body of the specification, but no such necessity has ever arisen in my experience.

47 X Q. Suppose you wished to indicate by means of a drawing a cone mixer having no baffles and being of a circular form in order to permit rotation of the contained liquid in the mass with a minimum amount of aeration, how would you represent such an apparatus and in what manner would it differ from the cone mixer designated by the letter A in Figure 1 of the drawings of the patent in suit?

A. I did not patent the cone mixer and therefore have never had any occasion to define its structure by means of a drawing. I used the convention which has been referred to, in the same way as I use any other convention in a diagram of a patent specification. I think that if I had occasion to illustrate the modified Gabbett in which the baffles were removed I should have to do so either by giving working drawings or by indicating in terms that the usual baffles were to be omitted. In a patent specification relating to a process, however, the necessity of going into details as to the
407 construction of well-known forms of apparatus does not arise, patent specifications in the metallurgical art being addressed to metallurgists.

48 X Q. The illustration of the Gabbett A in Figure 1 of the drawings of the patent in suit illustrates the outer cylinder or containing vessel as transparent, shows the cone mixer inside of the vessel, shows the shafts supporting the cone mixer, the bearings for the shafts, the pulley for rotating it, inlets for the various reagents, and for the ore and also shows the outlet. In what respect is this illustration conventional in the sense in which you have referred to

the pump as conventional, in other words, are not all of the various parts shown in detail except the baffles?

A. The drawing of the pump does not show either the piston or the valve which any engineer would know are used in the pump. The part marked A in the drawings roughly indicates a cone mixer and I notice from the mixer which is standing by me and which is marked "Sulman and Picard Slide Machine," one cannot see either the baffles nor the agitator from the outside.

The illustration of the cone mixer is conventional for two reasons, first, because the cone mixer was a well-known device, and secondly, because the patent is for a process, in which it is clearly stated that the ore pulp and a minute quantity of oil is to be vigorously agitated until the oil has been brought into efficient contact with all the mineral particles in the pulp, and it is pointed out that air
408 bubbles are to be introduced into the mass by agitation in such a way as to form a froth. It was obviously therefore proper to use merely a diagrammatic sketch in indicating one form of apparatus suitable for carrying the process into effect, because the directions given in the body of the specification were fully sufficient to enable any intelligent reader to understand what the mixing device was to do.

49 X Q. You say that in the actual plant there were three mixers but that you did not have room in the diagram of the patent in suit for three, thus accounting for the fact that but one appears in the diagram. You make this statement, do you not, in the belief that one mixer is sufficient to inform the operator, and that with that information he will not only supply baffles, if necessary, but will use one or more mixers according to the dictates of his intelligence?

A. In a patent specification relating to a metallurgical process, my view is that the body of the specification should inform the operator as to what he is to do to carry the process into effect, and a diagram is sometimes of assistance in showing the sequence of operations of the different elements in the process. I indicated a cone mixer in the drawing merely to make the diagram more complete, although so far as I can see the diagram might as well have contained merely a square or a circle bearing the legend "cone mixer" or "Gabbett mixer." In reply to the latter part of your question an operator does not require to "supply" baffles when using a cone mixer. If the cone mixer he buys is square, as they
409 most frequently are, no baffles are required, and if he buys a cone mixer which is cylindrical it will have baffles in it. If the operator made a cone mixer without baffles and found that the agitation was not sufficient to bring about to the greatest possible extent the object desired, I think that the dictates of his intelligence would lead him to increase the turbulence by the use of the ordinary baffles. So far as the patent in suit is concerned I think it is made clear that any number of cone mixers may be used in series and it is certainly made abundantly clear what the nature and result of the agitation is to be.

Adjourned to Saturday the 31st of August, 1912, at 10:30 A. M., at the same place.

London, September 2d, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Mr. Ballantyne continued:

50 X Q. Did you participate in the conference or some of the conferences between Messrs. Sulman, Picard and Ballot regarding their investigations?

A. I sometimes participated in the conferences, and sometimes met Messrs. Sulman, Picard and Ballot after they had conferred, and received from them information, instructions or questions.

410 51 X Q. Do you remember having any consultation with Messrs. Sulman, Picard and Ballot regarding the instructions given to Mr. Higgins to vary the different factors in the effect of those factors upon granulation, as set forth in Sulman and Picard's Report, March 3, 1905.

A. I had nothing to do with the drawing up of any instructions to the assistants of Messrs. Sulman, Picard and Ballot; indeed, beyond Mr. Chapman, Mr. Reed and Mr. Leechman, I did not know the assistants' names. I do remember in the early part of February, 1905, having a consultation with Messrs. Sulman, Picard and Ballot, at which they spoke of the investigations which they were about to make, and we discussed the method in which the results were to be indicated; and I particularly remember these gentlemen stating to me that in their investigations they were going to reduce the proportion of oil used in the Cattermole concentration process to a vanishing point, making the reduction step by step, and noting the results.

52 X Q. What was the purpose of these gentlemen in conferring with you upon this matter?

A. I cannot testify as to the purpose Messrs. Sulman, Picard and Ballot had in view in keeping me at all times fully informed as to the objects, progress and result of their investigations, but on my own behalf I can say that it has always been of the greatest possible assistance to me to be kept so fully informed, and I think my advice on patent matters has been of greater value to my clients than if

411 they had only brought to my notice completed inventions, or specific questions for legal opinions.

53 X Q. Did you approve of this project to experiment with varying quantities of oil in the investigation of the granulation process?

A. I merely listened to what was told to me; I offered no opinion on my clients' projects.

54 X Q. In the progress of this case frequent reference has been made by different witnesses to what they have termed a thick, persistent and coherent froth. Prior to the investigations by Mr. Higgins upon which the Patent in Suit is said to be based, had you seen any mineral-carrying froth that did not answer to this description of thick, coherent and persistent?

A. The question refers to "investigations by Mr. Higgins upon

which the Patent in Suit is said to be based." I ought first to state that such investigations as I saw in connection with the Patent in Suit were made by Messrs. Sulman, Picard and Ballot, although on two occasions Mr. Higgins was present and assisted in some of the manipulations.

Prior to April, 1905, I do not recollect ever having seen any mineral-carrying froth at all, and certainly I had not seen a mineral-carrying froth which answered to the description of thick, coherent and persistent. I recollect in some Froment tests seeing a froth of bubbles by which oily flocks of mineral were projected upwards or borne upwards, but I had never seen a mineral-bearing froth
412 before April, 1905, having any resemblance to the thick, coherent and persistent froth produced by the agitation froth process.

55 X Q. Does the process which you call the agitation-froth process always result in the production of this phenomenon which you term a thick, coherent and persistent froth as distinguished from the froth of bubbles which you say you have seen produced by the Froment procedure?

A. The process which I call the agitation-froth process is the process set forth in the Patent in Suit, and when that process is normally operated to its proper purpose and effect it results in this very characteristic phenomenon which I term a thick, coherent and persistent froth. The process as a whole is entirely distinct from the Froment procedure and the froth produced by the process of the Patent in Suit is quite distinct from anything which I had seen produced by the Froment process. The froth of bubbles which I had seen produced by the Froment procedure was produced in a test tube.

56 X Q. Did you see or participate in certain demonstrations of the process exploited by Minerals Separation Ltd., and purporting to be the process of the British patent corresponding to the Patent in Suit, when such demonstrations were made on behalf of Minerals Separation Ltd. in the suit brought in the High Court of Justice by the British Ore Concentration Syndicate Limited against Min-
413 erals Separation Limited upon certain patents granted to F. E. and A. S. Elmore? I refer to demonstrations made in the presence of complainants' representatives in that suit.

A. The question assumes that the demonstrations referred to purported to be demonstrations of the British Patent No. 7803 of 1905, and so far as I am aware, they did not purport to be so. In order that the suit might be properly tried, Messrs. Minerals Separation, Ltd., the defendants, admitted that in fact they used the process described in the British Patent No. 7803/1905 (which corresponds with the Patent in Suit). This agitation-froth process was well understood, and the comments of the judges show that they had no doubt as to the nature of the process. The defendants, Messrs. Minerals Separation Ltd., also gave the plaintiffs an opportunity of visiting the defendants' works on several occasions, as is the custom in this country in Patent Suits. I saw the demonstrations referred to.

57 X Q. Do you agree with the testimony given in that suit by Mr.

Horatio Ballantyne to the effect that not over 25 per cent. of the mineral which was floated by the process of Minerals Separation Ltd., when giving this demonstration of the process of the British patent, corresponding to the patent in suit, was floated in the form of a froth, the remainder being floated as a mere film?

A. As I have stated, the defendants, Messrs. Minerals Separation Ltd., gave the plaintiffs an opportunity of visiting the defend-
414 ants' works on several occasions and Mr. Horatio Ballantyne, a witness against Messrs. Minerals Separation Ltd., stated that, on the first occasion about a quarter of the whole concentrate was in the form of a froth, the balance being floated by what is called the oiled needle effect. Substantially I agree that on the first occasion this was so. Messrs. Minerals Separation Ltd., had a patent for a process based on the separation of oiled metalliferous particles from gangue by the oiled-needle effect, and it was fair and proper the plaintiffs should see Minerals Separation processes in all their modifications. As a matter of fact on this first occasion referred to the agitation froth process was not operating to its proper purpose and effect for two reasons. One was that the amount of ore available for that day's test was very small, quite insufficient to enable the plant to be used for carrying out the agitation-froth process properly, and the second reason was that the plant was a comparatively new one, designed, if I remember rightly, by Mr. Theodore J. Hoover, and the spitzkasten at this time was too large for use when the supply of ore was so small. If the question is intended to suggest that the breaking down of the froth on that occasion into a thin film was put forward as a part of the process of the patent in suit, I must repudiate the suggestion very forcibly, because it is within my knowledge that the circumstances of the trial on that particular occasion, and the breaking down of the froth into a thin film were thoroughly understood, and,
415. apart from this, demonstrations of the actual agitation-froth process were given, and full details of the method of carrying the process into practice were supplied to the plaintiffs and to the Court. At the date of the action referred to it was within the knowledge of all the experts engaged in the case that thousands of tons of thick, coherent and persistent agitation-froth had flowed over the lips of the spitzkasten in the various Minerals Separation plants.

I do not recollect discussing the Minerals Separation process with Mr. Horatio Ballantyne at all during the action referred to, but at the demonstration I spent the largest part of the day with Mr. James Swinburne, another witness against Minerals Separation, Ltd. We freely discussed the various processes.

By Mr. Scott: That part of the answer contained in the sentence beginning with the words "at the date of * * *" is objected to as hearsay.

58 X Q. In this suit of the British Ore Concentration Syndicate, Limited, against Minerals Separation, Ltd., the complaint was based, was it not, upon operations conducted by Minerals Separation, Ltd., which Minerals Separation, Limited, contended were included within

the British patent corresponding to the United States patent here in suit?

A. In the suit referred to, as in all patent suits, the complaint was that the patents owned by the plaintiffs were being infringed
416 by the defendants. It had been published that, among other processes, Minerals Separation, Ltd., were operating the agitation-froth process of the patent in suit, and that it had been successful in Australia in treating thousands of tons of ore. It had also been published that the process was used for testing purposes in London. Following upon this publication the plaintiffs asked the defendants if they would admit that the process of the patent in suit was being operated, and the defendants did admit it, and the agitation froth process was demonstrated in the High Court during the trial of the action, by Mr. Higgins and myself. The froth produced in the High Court certainly was more than an inch and a half thick and clearly showed to the Court what the agitation-froth process was and is.

59 X Q. What kind of an apparatus did you and Mr. Higgins use in the High Court?

A. A hand Gabbett.

60 X Q. Was this Gabbett in which the operation was intermittent, that is after agitating the pulp, did you simply permit the froth to rise upon the surface of the pulp in the mixing vessel?

A. Yes.

61 X Q. It was not a continuously operating apparatus then?

A. No. So far as I recollect an offer was made to the Judge to demonstrate the continuous form of the process and to let him see the agitation froth floating over the spitzkasten, but my recollec-
417 tion is not very clear. In any case the Judge did not come to the works.

62 X Q. Then in this suit in the English Court Minerals Separation, Ltd., did not make any demonstration of what you term the agitation-froth process, conducting the operations continuously by agitating the pulp in one vessel and permitting it to flow continuously to a spitz box upon which the froth formed, other than demonstrations which failed to float part of the material except as a film or by the greased-needle effect?

A. As I have stated the Judge did not come to the Works at all. The formation of the froth was clearly demonstrated to the Judge in Court, and the defendants admitted using the process described in the Patent in Suit, and the formation of the agitation-froth was discussed at great length. As to the demonstration at the works of Minerals Separation, Ltd., both the plaintiffs' and defendants' experts saw that the process demonstrated at certain times of the day at least was not the normal operation of the agitation-froth process, for the reasons I have stated. The nature of the agitation-froth process was however made perfectly clear to the Court.

63 X Q. Is it not a fact that three attempts were made by Minerals Separation, Ltd., to exhibit to the complainants in the suit of the British Ore Concentration Syndicate against Minerals Separation, Ltd., the operation of conducting in a continuous apparatus the so-

called agitation-froth process, and is it not a fact that in two
418 of these demonstrations the only mineral which floated was in the form of a film or by the greased-needle effect, and that in only one of the attempted demonstrations, was any froth at all produced, and in that one case the froth amounted only to about 25 per cent. of the total floated mineral, the remaining 75 per cent. in that instance floating as a film or by the greased-needle effect?

A. My recollection is that on one day the froth was rather good, but I do remember that during parts of the demonstration the froth was pulled out into a thin film for the two reasons I have stated, but of course it was never suggested by any one that when the agitation-froth was spoilt that it was still an agitation-froth, nor was it suggested by any one that film flotation of any sort or kind came within the scope of the Patent in Suit. The scope of the patents of Minerals Separation, Ltd., was not in issue, but only the scope of the Elmore Patents, and the High Court clearly held that Minerals Separation, Ltd., did not infringe the Elmore Patents and that the agitation-froth process was entirely distinct from the bulk-oil flotation process.

64 X Q. It was the purpose, was it not, of the demonstrations made by Minerals Separation, Ltd., in the presence of complainants in the English suit referred to, to exhibit the agitation-froth process and thereby to show that defendants were doing something different from the process of the Elmore Patent?

A. No. The counsel and experts for the plaintiffs were ad-
419 mitted in the defendants' works on three occasions for the whole day. They saw what was going on on these days and on one or more of the days they in fact saw operations in which the agitation-froth process was not effectively carried out and this was thoroughly understood, but the agitation-froth process was clearly demonstrated for the purpose of the action.

65 X Q. But Minerals Separation, Ltd., on these occasions when the agitation-froth process was not effectively carried out, was attempting to carry out the agitation-froth process was it not?

A. I do not know, I merely saw what was done.

66 X Q. Your information regarding these processes did not enable you to know what was going on or what was being attempted?

A. I have described what was going on and as to what was intended I can only speak for myself. When I intended to demonstrate the agitation-froth process to the Court I did so. The demonstration was perfectly clear, and I am prepared to repeat it at any time.

67 X Q. Are you prepared to repeat at any time the demonstration using the apparatus that was used upon the three occasions when the agitation-froth process was not effectively carried out, the three occasions referred to being those when the process was attempted by Minerals Separation, Ltd., in the presence of representatives of the British Ore Concentration Syndicate, Ltd.?

A. No.

68 X Q. Do you find anything in United States Patent
420 835,120, here in suit, that would teach the public anything with reference to the necessity of some particular relation be-

tween the sizes of the agitating apparatus or the amount of ore fed and the free surface of the liquid in the spitzkasten?

A. Yes. It is made perfectly clear in the Patent Specification No. 835,120 that the concentrate is to be removed as a froth and in particular it is made clear that when a spitzkasten is used, the froth is to be carried over the surface of the liquid in the spitzkasten into the receiving launder. It is a matter of simple trial to use a spitzkasten which will give a froth separation of the most efficient character. In all metallurgical processes the dimensions of the apparatus used and the relative dimensions must be to some extent decided by the conditions in each particular case. The Patent in Suit teaches the public how to obtain the agitation-froth and how to separate it as a froth.

69 X Q. You regard the relation of the free surface of liquid in the spitzkasten to the rate of ore feed as a very important element in the operation of the so called agitation-froth process, do you not?

A. The rate of feed of the various materials is of course of fundamental importance in the agitation-froth process. By following the instructions in the patent specifications it is a simple matter for a metallurgist to produce and separate the agitation-froth, but if the rate of feed of material is made abnormal, the operation of the process can be injuriously affected or prevented.

421 70 X Q. Your answer only refers to the rate of feed of the material. My previous question related more to the relation between the rate of feed of ore and the extent of free water surface in the spitzkasten, and was directed to ascertaining whether you did not consider this relation an important one, and one that must be adjusted within close limits. With this explanation will you answer the preceding question?

A. In my opinion the width of the spitzkasten should be such that for the given feed of ore, the agitation froth should float in the spitzkasten and be carried over the lip thereof. The object of the spitzkasten is to enable the froth to form and to float, and the reason for making the spitzkasten of substantial length, is to allow the gangue, particularly the gangue slimes, to settle down to some extent before the froth is taken into the launder. The various practical considerations are quite sufficient to enable the metallurgical engineer to decide in the case of a particular ore what size his apparatus should be.

71 X Q. Did you see the plant at Emu, Wales, in operation?

A. No.

72 X Q. In the Froment tests which you have seen or performed did you agitate the mixture of oil, ore and water before adding the mineral acid, or afterwards?

A. Generally when tests are being done by my clients I look on. However, I have personally tried the Froment process in both the ways you have mentioned.

422 73 X Q. When you prepared the application for the United States Patent No. 835,120 in Suit and the Applications for Patents in other countries upon the same subject matter, did you have before you, or were you conversant with the Froment British

Patent 12,778 of 1902, the document which is in evidence as "Froment Description" and the drawings which are in evidence as "Froment Plan" and "Froment Drawing A"?

A. I did not have the description and drawings before me and I was not conversant with them, but I had known the Froment patent specification No. 12778 of 1902, since August 1903, and I was conversant with the Froment process.

74 X Q. From your experience in the metallurgical art will you state whether the following described operations constitute the Froment process or the process which you intended to set forth in United States Patent 835,120, in Suit. An ore containing five per cent. calcite mixed with water to form a freely flowing pulp with oleic acid in a quantity to cause the production of a froth, with seventy to eighty pounds of sulphuric acid per ton of ore, the sulphuric acid being from 72 to 80 per cent. pure, which mixture is agitated sufficiently to cause the oleic acid to contact effectively with the metalliferous particles, the freely flowing pulp passing from the agitating vessel to a spitz box in which the froth is permitted to rise to the surface?

A. If the ore in the pulp (being presumably a sulphide ore) had been powdered so that a large part of it would pass through
423 a 150 mesh sieve, if the agitation were carried out in such a way as to bring the oleic acid into efficient contact with all the mineral particles, in the pulp and also to introduce air so that the bubbles or air films would adhere only to the mineral particles, and so that when the pulp was run into the spitz box a mineral bearing froth floated, the process which you have described would in my opinion come within the terms of the Patent in Suit, but I should have thought that that was a matter for the Court to decide.

75 X Q. How would the Court know whether the agitation were carried on in such a way that bubbles or air films would adhere only to the mineral particles, unless the Court were informed by some one having knowledge of the facts or having knowledge of what would take place when such operations were carried out or what has taken place when such operations were carried out?

A. The agitation-froth process of the Patent in Suit is a very simple and straightforward one. Any one accustomed to its use could recognize at once whether or not an operation of the kind you have described was giving an efficient agitation froth. The Court, I presume, can only decide what takes place in any particular instance from the evidence of an expert experienced in this particular art who has seen the operation performed.

76 X Q. In the light of the Froment British Patent No. 12,778 of 1902, the Froment Drawings and instructions which have
424 been introduced in evidence in this case, how would you proceed to apply the Froment process to a sulphide ore containing five per cent. calcite?

A. The Froment British Patent No. 12,778 of 1902, is vague and ambiguous and in several respects does not give a sufficient disclosure to enable a metallurgist to carry out a process for the concentration of ores in a satisfactory manner. The Froment descrip-

tion and drawings help to elucidate the specification and the essential features of the Froment process can be defined as follows: The process starts with an ore pulp consisting of powdered ore in water. The first step in the process is to add a suitable oil so as to unite the sulphide particles into what Froment calls "spherules" or what Sulman & Picard call "flocks." These are little masses of metallic sulphides moistened by oil and as stated by Froment they are at the first stage of the process imprisoned in the gangue. The next stage of the Froment process consists in liberating a gas in this mass, and Froment proposes to do this by the action of sulphuric acid on calcite or the like. The object of this second step is that the bubbles of carbonic acid shall attach themselves to the oily flocks of mineral and buoy them up to the surface. The third step in the Froment process consists in the separation of the concentrates from the oil in a hydraulic press or filter press whereby Froment states that a very large proportion of the oil used can be recovered. The fourth step in the process is the re-admission of the recovered
425 oil into the cycle of operations. Froment's concentrate according to his process was to be removed from the filter press in the form of cakes.

In the light of the Froment British Patent No. 12,778, of 1902, and the Froment drawings and instructions which have been introduced in evidence in this case, I should proceed to apply the Froment process to a sulphide ore containing five per cent. calcite in the following manner, but I do not know that I should achieve any measure of success.

I should crush the ore to 120 mesh, and remove the slimes therefrom by a de-sliming process. The powdered ore and water, in the proportion of 2½ kilogrammes of ore to 6 litres of water, would then be introduced into a mixing device. Assuming that the ore contained 30% of metalliferous matter, I should add engine oil to the extent of 56 pounds per ton of ore. The mixing device would then be put in operation until the sulphide particles had formed the required flocks with the oil. Froment, in his drawings and instructions, stated that the mass at this stage should be run into special vessels for holding the oiled ore. In any case the oiled pulp would be introduced into a second vessel in which the oiled ore would lie at the bottom, and this vessel would be filled with water. Means would be provided in this second vessel for introducing sulphuric acid, and means would also be provided for turning over the oiled ore at the bottom of the vessel, to allow the sulphuric acid to
426 get access to the ore. It is in this vessel that the most important step in the Froment process is intended to take place. The intention is that the sulphuric acid acting on the calcite shall evolve bubbles of carbonic acid, which will attach themselves to the oily flocks of mineral and buoy them to the surface, and from my experience I should expect that some of the flocks would, in fact, be raised in this way. To carry out Mr. Froment's instructions, the floating materials should be removed and introduced into a filter press, to squeeze out the bulk of the oil, leaving the product of concentration in the form of cakes. I have never carried out such an

operation as I have described, although I have tried the Froment process on a small experimental scale in the laboratory. The process is a very difficult one, and at various stages it requires great care. In the first place, the formation of the oily flocks or spherules of mineral and oil requires a good deal of adjustment, although my own experience has been that with ores containing thirty per cent., forty per cent., or fifty per cent., of mineral contents, the proportions of oil specified by Froment in the description put in evidence are such as to produce these oily flocks. As pointed out in Froment's specifications, there is also a proportion to be sought for a given ore and limestone, because in the Froment process it is important that the carbon dioxide shall be evolved from the sunken mass of ore in just such a way as will enable the gaseous bubbles to attach
427 themselves to the oily flocks and bring them up to the surface. Again, when the oily flocks come to the surface, there is in practice a good deal of difficulty, because the bubbles of carbon dioxide frequently burst, and let the flocks of mineral sink again. The process is one which, in my opinion, could not efficiently be carried into practice. It requires too many fine adjustments; the quality of oil necessary is prohibitive; the quality of acid necessary would be a very serious item on the large scale if the margin of profit were comparatively low; the filter press operation, in my opinion, would not be effective, and the adjustment of the amount of calcite and of its decomposition is also, in my opinion, too difficult for practical operation.

Even on the laboratory scale I have never experimented with an ore containing five per cent. of calcite, so that I cannot say what would happen in the operation above described. I have never come across an ore upon which the Froment process was tried without the use of added calcite.

77 X Q. The froth produced in the operation of the so-called agitation froth process is composed, is it not, of a large number of bubbles, more or less covered with the metallic sulphide particles of the ore?

A. In answering this question I shall have to make statements bordering on theory, and I am, therefore, expressing only my opinion. It is known to students of molecular physics that a persistent
428 froth of air and water cannot be produced unless the water films are contaminated. In my opinion the froth produced in the operation of the agitation froth process set forth in the patent in suit is composed of bubbles of air, the walls of which consist of water contaminated with myriads of particles of very finely divided sulphides, and the surface tension relationship between the sulphide particles on the one hand, and the water and air on the other hand, has been altered by the minute trace of oleic acid or other oil. An inspection of the agitation-froth shows that the walls of the bubbles are contaminated by these sulphide particles; and it is a fact that the agitation-froth process operates most effectively when a large proportion of the sulphides is in the form of slimes; that is to say, when a large proportion of the sulphides will pass through a screen of 150 or 200 meshes to the linear inch. It is noticeable in the agitation-

forth process that the sulphide particles still retain their natural appearance, and they are not in the form of flocks.

78 X Q. In any event, the froth formed as a result of the operation of the so-called agitation-froth process consists of bubbles, the walls of these bubbles being formed of water contaminated by or containing metal sulphide particles, the formation of such sulphide-bearing bubbles being promoted by the oil present. Is this not correct, disregarding for the moment any scientific discussion of the minutiæ of the matter?

A. This is correct, and it is a remarkable fact that this char-
429 acteristic agitation froth can only be produced by the process described in the patent in suit, so far as I am aware.

79 X Q. Froment in his British patent states that the bubbles of the gas become covered with an envelope of sulphides. Isn't this expression a pretty fair description of the so-called agitation-froth which is formed of bubbles, the walls of which are composed of water containing metal sulphide particles?

A. No. In the first place in the passage referred to, it is the bubbles of the liberated gas, namely the carbonic acid gas, to which Froment refers. In the second place it is not suggested in the passage from Froment's specification that the bubbles have walls consisting of water-films, and there is certainly nothing in Froment's specification suggesting a froth in any way resembling the agitation froth produced by the process of the patent in suit. In my opinion a confusion has arisen in the specification of Froment. When the Froment process is tried with a test tube, the carbonic acid gas is confined within a narrow space. Such flocks as are floated are caught on the top of the rising body of gas and so one frequently finds a layer of carbonic acid gas bubbles which are clean and which have of course water walls, and above that an envelope of the sulphides which are in the form of oily flocks. The bubbles of carbon dioxide actually in contact with the oily flocks have in my opinion walls of oil. When the Froment process is carried out on a larger scale as in the
430 experiment described in the testimony of Mr. George A. Chapman the oily flocks rise away from the ore individually with bubbles of carbon dioxide gas attached to them and in such cases also, in my opinion, the walls of the bubbles of carbon dioxide are oil. It goes without saying that in no case in the Froment process is a froth produced consisting of bubbles of air, the walls of which are water films contaminated by myriads of individual sulphide particles which are not "moistened" with oil, as is the case in the agitation froth. I am also of opinion that in the case of a document like Froment's British Patent specification No. 12,778 of 1902, one cannot obtain a proper idea of the process which the patentee intends to disclose by selecting out and reading a short passage divorced from its context, but that to appreciate the process one must see what the whole intention of the patentee is and, if possible, what he actually does when the process is reduced to practice.

80 X Q. Will you state what your reasons are for your conclusion that the operation set forth in X Q. 74 would not conform to the procedure directed in the Froment British Patent 12,788 of 1902?

A. The operation set forth in 74 X Q. is not the Froment process and would not conform to the procedure directed in the Froment British Patent No. 12,778 of 1902 for the following reasons:

In the first place, the amount of oleic acid necessary to cause the production of a froth in such an operation would be one and
431 a half to two pounds of oleic acid per ton of ore. Such a proportion would not in any sense conform to the Froment procedure. Such a proportion of oleic acid as would cause the production of a froth would not cause the production of spherules or flocks of metallic sulphides as required by Froment, indeed such proportion would not "moisten" the sulphides at all.

In the second place, if the mixture were agitated sufficiently to bring about effective contact with the metalliferous particles of the quantity of oleic acid necessary to cause the production of a froth, and if the sulphuric acid were present, a reaction would take place between the sulphuric acid and the calcite in the agitating vessel and the carbonic acid gas would almost completely escape so that there would be substantially no calcite or no sulphuric acid in the pulp when it reached the spitz box, or in other words the essential characteristic of the Froment process, namely the liberation of CO^2 in a mixture of gangue and imprisoned spherules of oiled sulphides would never take place.

In the third place, I do not know that an ore containing five per cent. of calcite would necessarily give the Froment phenomenon at all.

In the fourth place, if the agitation were carried out in such a way as to introduce air into the pulp as in the agitation froth process, an agitation froth would be produced.

In the fifth place, my experience is that the Froment pro-
432 cess cannot be carried out by agitating the mixture of the kind described in an agitating vessel and then running the pulp out into a spitzkasten.

In the sixth place, such a quantity of oleic acid as would cause the production of a froth could not conceivably be removed from the concentrates by a filter press and readmitted into the cycle of operations. The amount of oleic acid necessary to produce a froth is so minute that it cannot be seen under a microscope; it is not apparent to the touch. In my opinion a filter press would leave on the concentrates a very much larger quantity of oleic acid than is necessary in the first instance in the operation referred to.

Adjourned to Tuesday, September 3d, 1912, at 10:30 A. M., at the same place.

London, September 3d, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Mr. Ballantyne continued:

81 X Q. With reference to the first reason set forth in your answer to cross-question 80 why the operations there referred to would

not conform to the procedure directed in the Froment British Patent No. 12,778 of 1902, I invite your attention *the* the fact that Froment directs the use of a thin layer of ordinary oil and to the
433 further fact that in the Froment instructions of record Froment refers to the advisability of varying the quantity of oil and mentions an amount equal to one per cent. (whether the one per cent. is to be figured upon the ore as an entirety or upon the metalliferous content is not explicitly stated). In view of these statements appearing in Froment's Patent and instructions, do you not think that a metallurgist would in the exercise of ordinary common sense vary the quantities of oil in order to secure the maximum flotation of valuable mineral in the manner that a metallurgist would likewise vary the quantity of oil used in the operations set forth in the patent in suit?

A. In 1902, the "oil process of ore concentration" referred to by Froment was the Elmore bulk-oil process which was the only one publicly known or tried on the commercial scale, and in that process the layer of oil added was very thick and amounted to from 100 to 300 per cent. on the ore. The Elmore bulk oil process was tried at the Traversalla Mine in Italy where Mr. Froment was the engineer and it is clear to me that Froment wished to use a smaller quantity of oil than Elmore did.

With regard to the direction in Froment's specification to use a thin layer of ordinary oil, this direction refers to an experiment in a test tube. I notice that Froment suggests the use of a few drops of sulphuric acid but does not suggest the use of merely a few drops of ordinary oil, but "a thin layer" of ordinary oil. I have fre-
434 quently tried the Froment process in a test tube and I find the thin layer of oil amounts to not less than about 5 per cent. on the weight of ore (that is 112 pounds of oil per ton of ore).

I have also found that in a test tube experiment such an amount of oil is in fact necessary to cause the sulphides to be moistened by the oil and to unite into the flocks or spherules required in the Froment process. Turning for a moment to the agitation-froth process I point out that no metallurgist would ever think of adding a thin layer of ordinary oil to the pulp in that process. It would be ridiculous to attempt to carry out the agitation-froth process in a test tube by additions of the type suggested in the Froment test. Assuming that the test tube contained ten grammes of sulphide ore, the amount of oil necessary to give the proportions required for the agitation-froth process would be one-fifth of a drop or less, an addition which of course is out of the question.

It must be borne in mind that the proportion of oil used in the Froment process must be such as to produce the spherules or flocks of sulphides moistened with oil and in my experience, with the ores I have tried, the amount of oil necessary for the Froment process varies from about twenty-five times to about forty times the amount of oil necessary in the agitation-froth process, and in any case the quantity of oil necessary for the Froment process is always many
435 times the quantity required for the production of an agitation froth. Turning to the Froment instructions of record it is clear that Froment recommends that the quantity of oil should be

to some extent varied in proportion to the metalliferous contents. I have not tried the Froment process on ores containing less than 10 per cent. mineralization and as far as I am aware the process has not been tried with such ores, but taking ordinary ores with a mineralization of from 10 per cent. up to 50 per cent. the proportion of oil recommended by Froment in his instructions varies from 44.8 pounds of oil per ton of ore containing from 10 to 15 per cent. mineralization, up to 78.4 pounds of oil per ton of ore containing 40 to 50 per cent. mineralization. I am strongly of opinion that these proportions could not be reduced within the limits of the Froment process. In view of these statements appearing in Froment's Patent and instructions, I am satisfied that a metallurgist would in the exercise of ordinary common sense use the quantities of oil necessary for the formation of the flocks or spherules which are in my opinion the quantities recommended by Froment.

Turning to the agitation-froth process described in the Patent in Suit. It is clearly stated on page 1 line 96 "the minimum amount of oleic acid which can be used to effect the flotation of the mineral in the form of a froth may be under 0.1 per cent of the ore; but this proportion has been found suitable and economical." This
436 statement clearly directs the metallurgist to use 2.24 pounds of oil per ton of ore or less and my experience is that 2 pounds or one and a half pounds of oil per ton of ore is an ideal standard for the agitation froth process. In the agitation-froth process the minute trace of oil added is not proportioned to the metalliferous constituents of the ore. In my opinion a metallurgist in putting into operation the agitation-froth process would start with 0.1 per cent. of oleic acid on the ore, and this would probably give him a good result. If he found that there was a tendency for some of the metalliferous particles to agglomerate together and sink he would reduce the quantity of oil from say 2 pounds of oil per ton of ore down to say 1½ pounds of oil per ton of ore.

Apart from these considerations as to the proportion of oil used which bring out fundamental distinctions between the froment process and the agitation-froth process, I wish to say that no fanciful or imagined variations in the quantity of oil necessary in the Froment process could possibly convert the Froment process (which depends upon certain phenomena) into the agitation-froth process which depends on a very unique, characteristic and entirely distinct phenomenon.

Referring again to the first reason set forth in my answer to 80 X Q., the quantities of oil necessary in the Froment process would be quite unsuitable to cause the formation of an agitation-froth.
437 82 X Q. Suppose you were treating an ore containing five per cent. of zinc sulphide, the rest of the ore being gangue of such a character as not to interfere with the flotation of the blende, and that you used suitable oil in quantity equal to 1 per cent. by weight of the ore, agitated the pulp in a suitable apparatus, such as a Gabbett mixer, it being presupposed that the ore contains either naturally or by addition thereto one per cent. of calcite, and that sufficient sulphuric acid has been added to react with all of the calcite, that after agitation the Gabbett is stopped and the blende allowed

to float, would not each step so performed be in accordance with Froment's patent as directed in lines 33 to 39 page 2 of the British Specification, except for the adjustment of the quantity of calcite and oil to the figures mentioned in his instructions. My question is not directed to ascertaining what results would be obtained by this operation, or what form of float would be secured but is directed towards ascertaining whether the steps set forth in the question, irrespective of the result produced, would not conform to Froment's British Patent and instructions as defined in the preceding part of the question?

A. The last sentence of your question contains suggestions with which I entirely disagree. For example the agitation-froth process does not consist in a series of steps but embodies, as I have stated, a unique and very remarkable phenomenon. In short, the agitation-
froth phenomenon is produced by agitating the ore pulp with
438 a minute trace of oleic acid or other suitable oil so as to form
the agitation-froth, and the proportion of oil recommended in the Patent in Suit is 0.1 per cent. on the ore or less. Again, the suggestion that the results obtained are not to be taken into consideration seems to me to be extraordinary because, leaving out of consideration the particular operations referred to, it is obvious that if a certain operation results in the formation of the agitation-froth, the operation is the agitation-froth process; whereas on the other hand if a certain series of steps results first in the formation of the Froment spherules, results secondly in the generation of CO_2 which removes these spherules from the gangue in which they are imprisoned, and floats them to the surface of a pulp, and yields a concentrate from which the oil, or the larger proportion thereof can be squeezed out in a filter press, it is obvious that the Froment process would be used. Putting briefly my objection to the last sentence of your question, both in the Froment process and in the agitation froth process, the phenomena or phenomenon, or the operation leading thereto cannot be intelligently considered entirely irrespective of the results produced.

I also wish to enter a protest against the suggestion contained in the first part of the question. When an important patented invention has been made, reduced to practice, and well-established, it is a common thing to take patent specifications relating to earlier sugges-
tions which have not come to anything, and by piecing
439 together various suggestions from these old documents and
applying to these the expert knowledge and experience gained from the later and successful invention, to attempt to produce something which would bear some relation to that later and successful invention, and any such suggestion seems to me very improper. For example, in your question it is suggested that the operation shall be carried out in a Gabbett mixer, and if this were done in such a way as to beat air into the mixture the operation would be quite inconsistent with the Froment process. I have not tried any experiments with an ore containing five per cent. of zinc sulphide. Froment's specification and instructions do not suggest the application of his process t osuch an ore, and Froment's speciqcation does not specify the amount of oil to be used with such an ore, except that the

amount of oil must be sufficient to form the spherules of sulphides moistened with oil which after the first stage of the process are imprisoned in the gangue.

Now answering your question more specifically the steps which you suggest would not be in accordance with the passage in Froment's specification referred to nor would they be in accordance with the obvious intention of Froment in his specification. The various constituents of the mixture being all agitated together in the Gabbett, I should expect that the first thing would be that the sulphuric acid would attack the calcite, and evolve CO_2, which would be beaten out of the pulp or washed out by the constant stream of air which
440 comes into and out of the pulp during the Gabbett agitation. The quantity of oil being about ten times the amount necessary for the production of an agitation-froth (that is to say ten times the amount stated in the Patent in Suit to be suitable and economical). I should next expect that the oiled sulphides would agglomerate together into little loose flocculent masses. The beating in of air in the Gabbett would, in my opinion, effect an air-attachment to some of these flocculent masses; and when the agitation is stopped I should expect that the great bulk of the flocculent masses of oiled zinc sulphide would sink with the gangue and possibly there would be a little floating oily matter, some floating flocks with air-attachments.

It is fundamental to the Froment process that when the spherules or flocks of oiled sulphides have been formed and are imprisoned in the gangue, carbon dioxide shall be liberated in that mass in just such a way that the bubbles of CO_2 shall attach themselves to the spherules and buoy them up to the surface. No such phenomenon could take place in the operation set forth in your question. I should say that the operation would be a wasteful and ineffective way of producing a large amount of agglomeration of sulphides which would mostly sink. Against it is a feature of the Froment process that the oil shall be squeezed out of the concentrate and returned to the cycle of operations. I am of opinion that this step could not be effectively carried out after the operation you have defined.

441 One per cent. of ordinary oil such as the oil used in 1902, namely, engine oil, which is a residuum oil, would not form the thin layer required by Froment.

Froment's intention in stating a proportion is to be sought for a given ore and limestone is clearly that the proportion used and the series of operations shall be such that when the oil spherules are resting at the bottom of the vessel imprisoned in the gangue the generation of CO_2 shall then take place in that mass in just such a way as to obtain attachments of CO_2 to the oily flocks for the purpose of floating them; as I have stated this is difficult to obtain and it would be absurd to attempt to bring about such a method of separation by mixing all the re-agents and agitating them in a Gabbett or cone mixer.

By Mr. Scott: The answer of the witness is objected to as argumentative and irresponsive. This objection is made with respect to the following statements among others. The dissertation upon what

the "agitation-froth process" does or does not consist in, beginning with the words "For example * * *"; the sentence beginning "Again, the suggestion * * *" is irresponsive and evasive; the reference to a filter press is irresponsive and volunteered; the passage beginning "I also wish to enter a protest * * *" is wholly argumentative and irresponsive, being merely the witness's argu-
442 ment at large upon what he thinks takes place under certain circumstances in patent suits. The passage beginning "The various constituents * * *" is irresponsive and volunteered in that the question is limited to asking whether certain steps or operations irrespective of their results would be in accordance with Froment's Patent and instructions, and the same criticism applies to the ensuing remarks upon what the witness should expect.

83 X Q. Froment, in his instructions, refers, does he not, to the treatment of an ore containing up to five per cent. of metals, and the ore referred to by me as containing five per cent. of zinc sulphide falls within Froment's reference to an ore containing up to five per cent. of metal, does it not?

A. The passage in Froment's instructions relates to ores containing metallic matter such as copper and lead. His instructions and his patent specification do not in fact mention zinc, but this is an unimportant matter because the Froment process has in fact been tried with zinc ores. The answer to your question is yes.

84 X Q. In connection with an ore containing up to five per cent. of metal Froment in his instructions specifies the use of one per cent. of oil, does he not?

A. Such a suggestion does occur in the Froment instructions, but so far as I am aware the suggestion is not based upon any practical results and I personally have not experimented with a zinc ore of the low mineralisation referred to in your preceding question.

443 By Mr. Scott: All of the answer after the word "instructions" is objected to as irresponsive and volunteered.

85 X Q. Froment describes the use of a mineral acid such as sulphuric acid as part of the process set forth in his patent, does he not?

A. Froment describes the combined use of a gramme of limestone and a few drops of sulphuric acid in the test tube experiment.

86 X Q. And Froment in his patent describes the admixture of the ore, limestone, water, acid and oil before agitation, does he not?

A. Froment in his patent suggests a test in a test tube, in which test, ore, limestone, water, acid, and a thin layer of ordinary oil are introduced into the test tube, and the mixture then agitated for a brief space.

87 X Q. You have frequently used the expression or an expression equivalent to the following: Agitated so as to introduce air. Is there any kind of agitation that would cause efficient contact of oil in quantities as low as one per cent. of the ore which the metalliferous mineral particles of the ore, that would not cause air to be entrained in the liquid?

A. Except by using extraordinary expedients such as an agitation

vessel in vacuo, or an agitation-vessel completely closed and completely filled with pulp I cannot at the moment suggest any kind of agitation for the purpose referred to, that would not cause air
444 to be entrained in the liquid, but I have not tried any experiments for the purpose of oiling an ore in a pulp without entraining any air into the pulp.

88 X Q. Now referring to Complainants' Exhibit Froment Plan and Complainants' Exhibit Froment Description I invite your attention to the fact that Froment states that the vat designated by the letter B is one and seven-tenths meter in diameter and .5 meter deep. And that according to this scale the agitating vessel or mixer designated by the letter A would have a diameter of approximately one meter, that Froment states in his description that the agitating vessel A contains two stirring devices which work in opposite directions at about three hundred revolutions per minute. I ask you whether the operation of such stirring devices in Froment's agitating vessel A would entrain air into the liquid contained therein and cause the entrained air to efficiently contact with the mineral particles contained in the liquid?

A. So far as I am aware a plant following the Froment drawing had not been made to the scale you mention. It is in evidence that an experimental plant on a smaller scale was received by Minerals Separation, Ltd., from Mr. Froment, but I did not see it. It is impossible for me to say whether air would be entrained in the agitator referred to. As the meaning of the word "entrained" is not very definite, I may say that in my last answer I used the word "entrained" meaning that the air would be drawn into the liquid;
445 of course, normally the air would come out again and the question whether any air would remain in an agitated liquid depends on other considerations. In my opinion in the first agitator of the Fremont apparatus air would pass into the pulp and out again.

89 X Q. Is the first agitator of the Froment apparatus in any respect different from what you term the cone mixer in respect to the action of drawing air in and permitting or causing said air to pass out again?

A. Never having seen the first agitator of the Froment apparatus, I cannot say.

90 X Q. With the apparatus which you term the cone mixer, is it your opinion that air is drawn in and then forced or permitted to flow out again?

A. When the cone mixer is used in the conditions set forth in the patent in suit, air is drawn in and then forced or permitted to flow out again in enormous quantities.

91 X Q. In what way have you determined this as a matter of fact, by what mode of observation or test?

A. As an example of numerous tests which are conclusive on this point, I have put the cone mixer into operation for one or two seconds, using vigorous agitation when the cone mixer has contained plain water and other liquids or pulps, and I have seen the air bubbles scouring through the water even in this short time.

92 X Q. You have stated that in trying the Froment process in

a test tube, you find that a thin layer of oil amounts to not less than five per cent. on the weight of ore. Does not the rela-
446 tion between the amount of oil forming the layer and the weight of the ore depend upon the shape of the test tube? If the test tube happened to be a long, narrow test tube, would not the percentage of oil to ore be much smaller than if you used a very wide test tube?

A. I have already stated that I consider that Froment's expression "thin layer," is used in contradistinction to the well-known thick layer in the Elmore process. In my opinion, the test tube experiment suggested in Froment's specification is quite insufficient to disclose any method of ore concentration. I have tried the test and used an ordinary test tube suitable for taking the mixture suggested, and my previous answers were based on these tests. It is obvious that in a specially narrow test tube the quantity of oil would occupy a greater thickness or height than in an ordinary test tube.

93 X Q. In a narrow test tube, would not a smaller quantity of oil make a thin layer than would be necessary to make a thin layer in a test tube of greater diameter?

A. Yes.

94 X Q. If you were to use a test tube of ¾ of an inch in diameter and one 1½ inches in diameter, would not the relation between the amounts of oil necessary to constitute a thin layer be approximately in the ratio of 1 to 4?

A. To constitute a layer of the same thickness, yes. I
447 have not got my test tubes here, but I think they are ¾ of an inch or ⅞ of an inch in diameter.

95 X Q. Wouldn't the quantity of oil necessary to form a thin layer upon the liquid in a test tube also be governed largely by the degree of viscosity of the oil used?

A. Yes. Froment used the ordinary oil in use in 1902, namely, engine oil which is a mineral oil residuum, and that was the oil used in my test. It is obvious from the preceding answers that the suggestion contained in Froment's specification of a test in a test tube is utterly inadequate to give any sufficient disclosure of the quantity of oil to be used.

96 X Q. Do you find the word "flocks" anywhere in the Froment specification or in the Froment description?

A. No. It would have been more correct in my answers to have adhered throughout to the expression "spherules" employed by Froment. The essential first step in the Froment process is to form little masses of sulphides moistened by oil and throughout my evidence I have used the word "flocks" in the sense of these little oily masses only.

97 X Q. Did you use the word "flocks" in the sense in which it has been applied to the particles formed at one stage of the Cattermole process?

A. I did, but the little oiled masses of mineral in the Froment process contained more oil than the flocks in the Cattermole process. I know this because it is impossible to squeeze any oil out

448 of the Cattermole agglomeration of flocks, whereas the little oily masses in the Froment processes were, according to his directions, to be collected together and squeezed to remove oil for re-use.

98 X Q. In operating under these conditions where Froment directs the use of oil equal, say, to one per cent. of the ore, would you be able to squeeze the oil out of the particles formed?

A. Yes. If the ore contained one per cent. of metal, the concentrate, if it were perfect, would contain one hundred per cent of oil. If the ore contained 2 per cent. of metal the concentrate would contain 50 per cent. of oil, and so on. As a matter of fact, in the Froment process the concentration is anything but complete and the concentrate is very oily. In my opinion, by squeezing such a concentrate, the proportion of oil could be reduced to about 10 per cent. to 8 per cent.

99 X Q. You answer upon the theory that all of the oil becomes attached to the metalliferous particles, do you not?

A. I answer upon the theory that all of the oil either becomes attached to the metalliferous particles or floats.

100 X Q. Would this be the case also in what you term the agitation froth process?

A. The proportion of oil used in the agitation-froth process is one and a half pounds or two pounds per ton of ore (i. e.; about 0.1 per cent. or less as recommended in the patent in suit).

449 This is a very minute quantity and in my opinion the oil furnishes a microscopic film on the sulphide particles. In the agitation-froth process it is a fact that practically all of the oil becomes attached to the metalliferous particles, but the quantity is so small that it cannot be seen under the microscope.

101 X Q. Is this process that you call the "agitation-froth process" the process defined and claimed as I understand by yourself, in the United States Patent 835,120 in suit?

A. Yes.

102 X Q. Then this so-called agitation-froth process even by the terms of that patent may be conducted under some circumstances at least, by the use of an amount of oil equal to practically one per cent. by weight of the ore, or to conform to the precise directions of the patent, less than one per cent. by an amount infinitely small, say .9999 per cent. This last amount of oil would be a fraction of one per cent. would it not, as contemplated by the patent?

A. In my opinion the operation of the agitation-froth process is defined in the clearest possible terms in the patent in suit, and this remark applies particularly to the quantity of oil to be used. It is a fact that 0.1 per cent. of oil on the weight of ore is a suitable and economical quantity to use for the production of the agitation-froth, in the instance given in the patent and in those instances where I have seen the process in use. Less oil than this may also in some instances be effectively used as stated in the patent in suit.

450 It is further made clear in the patent in suit that the quantity of oil used must not be such as to cause agglomeration as in the Cattermole process. If a metallurgist used a quantity of oil

sufficient to cause the sulphide particles to agglomerate and sink, he would be using too much oil for the process of the patent in suit; and further, if a metallurgist was minded to carry out the agitation-froth process as defined in the patent in suit, and if he used more oil than is necessary to produce the agitation-froth, he would be doing something wasteful, and in ore concentration economy is of first-rate importance. The fact is that Sulman, Picard and Ballot found that when the proportion of oily substance was considerably reduced from the Cattermole quantities, and after vigorous agitation of the pulp, the tendency of the froth to form began; and when the proportion of oil was reduced to 0.1 per cent. they found that an efficient agitation-froth was produced. I have never seen the agitation-froth process successfully carried out by the use of an amount of oil equal to practically one per cent. by weight on the ore, and in my opinion 0.9999 per cent. of oil would not be a proper quantity (that is to say, it would not be a suitable and economical quantity), as contemplated by the patent and would not therefore be a suitable fraction of one per cent. as contemplated by the patent.

103 X Q. Referring now to the second reason given in your answer to cross-question 80 why the operations set forth in cross-question 74 would not conform to the procedure directed in Froment's
451 British Patent, you state in effect that if the acid and calcite were present during the agitation, the carbonic acid gas would almost completely escape so that there would be substantially no calcite, or no sulphuric acid in the pulp when it reached the spitz box. The agitation of the mixture containing ore, water, oil, calcite and sulphuric acid would not constitute a departure from the directions contained in the paragraph beginning on line 33, page 2 of the Froment patent, would it?

A. The Froment patent in the passage referred to merely suggests a test in a test tube which is of no real use. The only document I have seen disclosing Mr. Froment's idea of how to carry his process into effect is that in evidence as Froment description. I have stated that the operation suggested in 74 X Q. is not the Froment process, and in this connection it is important that that operation is entirely distinct from and inconsistent with the Froment process as set forth in the Froment description. 74 X Q. stated that oleic acid is used in a quantity to cause the production of a froth, and also that when the pulp passed into the spitz box the froth is permitted to rise to the surface.

In the agitation-froth process the time element or the contact period is of great importance. The pulp in the agitation-froth process contains a large proportion of very finely divided mineral particles. It is fundamental that the minute bubbles or films of air shall collect all these minute sulphide particles. The time of agitation necessary for this collection is the time element or con-
452 tact period to which I have referred, and the froth cannot properly be obtained or separated on the spitzkasten until this time of agitation has been completed. During this time there is beaten into and out of the pulp a quantity of air many thousand times that which is included ultimately in the froth, and during that

time I am satisfied that the carbonic acid gas would almost completely escape. Sulphuric acid and calcite cannot exist together under the circumstances described; they are bound immediately to react until one or other is completely destroyed, so that the carbon dioxide formed disappears during the time interval I have referred to, and I am satisfied that if the process were carried out so as to form a froth, there would be substantially no calcite or no sulphuric acid in the pulp when it reached the spitz box.

104 X Q. I presume it is your opinion that a competent metallurgist reading the Froment patent would understand that suitable apparatus was to be used in carrying out the process which Froment described?

A. A competent metallurgist reading the Froment patent would see that it does not adequately disclose any process of ore concentration, and certainly he would require to find out how the process in fact was to be carried out, and what apparatus was to be used. When I negotiated for the purchase of Froment's patent, on behalf of Mr. Ballot and his associates, I made it clear, or it was made clear, that Mr. Froment would have to give particulars as to how his
453 process was to be carried into effect, and what apparatus was to be used, and the particulars supplied have been put in evidence.

105 X Q. When did you first see these particulars, by which I understand you refer to the Froment plan and Froment description?

A. I actually saw them only quite recently, within the last month, but in the latter part of 1903, in the early part of 1904, and at various times since then, I have discussed the Froment process with my clients, and I have seen attempts made to carry it into effect, although not in the apparatus supplied by Mr. Froment.

106 X Q. From the testimony which has been given in this case, and with which I understand you are familiar, I take it that the parties interested in Minerals Separation, Limited, completed the purchase of the Froment British patent prior to receiving Mr. Froment's description, plan and apparatus?

A. Yes.

107 X Q. In the practice of the operation described in paragraph beginning line 33, page 2, of the Froment British patent you do not think that a competent metallurgist would, in the exercise of his professional information adopt what you call a Gabbett or cone mixer, or similar agitating apparatus for the purpose of giving effect to the process on a larger scale than could be carried out in a test tube?

A. I have tried the operation described in the passage referred to, and have never succeeded in obtaining any useful result. I know exactly what a group of the most competent metallurgists,
454 intimately acquainted with everything connected with ore concentration by oil, actually did in trying to put the Froment process into practice. Their efforts have been briefly stated in evidence by Mr. H. L. Sulman, Mr. A. H. Higgins, Mr. George A. Chapman and other witnesses, and I know that my clients and their assistants made strenuous endeavors to get some useful results

from the Froment process, but without avail. As a matter of fact, my clients did use a Gabbett or cone mixer for oiling the ore in the Froment process; that is to say, in place of the first agitator in the "Froment Drawing."

108 X Q. Is it your conclusion then that the use of a cone mixer, or some similar known agitating mechanism, would naturally occur to a metallurgist as an instrumentality for carrying out the agitation directed by Froment?

A. Certainly not. Messrs. Sulman, Picard and Ballot were, to my knowledge, the first to introduce the use of the cone mixer in the Cattermole process, and they found that it was particularly suitable for oiling the sulphides in an ore pulp. It is in evidence that this apparatus, which was in my clients' laboratories, was used in place of the first vessel or agitation vessel in the Froment plant. The Froment drawing and Froment description clearly show what did occur to Froment himself when he wished to carry his process into effect, and in my opinion Froment was the best, if not the only, judge, as to what the Froment process should be when reduced to practice.

109 X Q. My question was not restricted to the cone
455 mixer, but included any well-known mechanical agitator. Is it your idea that these competent metallurgists, reading the Froment patent, would infer therefrom that Froment recommended the commercial concentration of ores by the use of test tubes?

A. No. My idea is that competent metallurgists would do what my clients did, namely, obtain full particulars from Mr. Froment as to what his process really was, and what apparatus was to be used, and also work out by themselves as far as possible some method of carrying the process into effect. It is clearly in evidence what, in fact, was done.

110 X Q. It is not your belief then that the cone mixer was such a well-known apparatus to metallurgists that its use would naturally occur to them as an instrumentality for carrying out the step of agitation of a liquid mixed with other ingredients?

A. If the Froment drawing and Froment instructions had been published, which they were not, the metallurgist would have been furnished by Mr. Froment with the necessary information as to the type of agitator to be used in the first stage of the Froment process as defined in these instructions. It is quite impossible for me to say whether it would naturally occur to a metallurgist to substitute for Froment's first vessel or agitator the well-known cone mixer or Gabbett, but I know that Sulman, Picard and Ballot did use the cone mixer both in the Cattermole process and in some of the
456 tests of the Froment process in place of Froment's first vessel or agitator.

Adjourned to Wednesday, September 4th, 1912, at 10.30, at the same place.

London, September 4th, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination of Mr. Ballantyne continued:

111 X Q. You have referred to Minerals Separation having a patent for a process based on the separation of oiled metalliferous particles from gangue by the oiled needle effect. Will you please state what patent you refer to?

A. I refer to the United States Patent 879,985 patented February 25, 1908, on an application filed February 20th, 1905, and may add that the application for this patent is referred to in the patent in suit on page 2, lines 37-39.

112 X Q. Did Minerals Separation Ltd, in their efforts to apply the process of the Patent 879,985 use the apparatus shown in that patent?

A. I have seen the apparatus illustrated in Figure 1 of that patent in use at the works of Minerals Separation Limited. Indeed, Figure
1 is a perspective view of the actual apparatus, made by my
457 firm's chief draughtsman from sketches made in my presence.
The same remark applies to Figure 2. In the case of Figures 3 and 4 I have never seen an actual apparatus of this form although I have seen the process experimented with on a rocking conveyor of curved form. The bulk of the experiments along this particular line were done in a cylinder of which I can supply an actual drawing.

113 X Q. Did Minerals Separation Limited use the agitator and spitzkasten apparatus similar to that employed in the demonstrations made during the progress of the suit of British Ore Concentration Syndicate Limited against Minerals Separation Limited for the production of the oiled needle flotation effect, described in United States Patent 879,985?

A. No. The agitator and the first spitzkasten were used to carry out the process of the patent in suit, namely, for the production and separation of the agitation-froth. Thereafter the tailings from the first spitzkasten were sometimes treated by some process involving the oiled needle effect as recommended in the patent in suit, but in so far as the agitation froth process itself is so extraordinarily efficient, this subsequent treatment of the tailings was superseded by the other form of re-treatment recommended in the patent in suit, namely, by the agitation-froth process itself, and this latter procedure has been the constant practice of Minerals Separation for a long time.

114 X Q. Then the demonstrations performed by Minerals
458 Separation Limited during the progress of the suit brought by the British Ore Concentration Syndicate Limited were not intended to produce the oiled needle effect, but were intended to produce the froth effect. Is that right?

A. I cannot testify as to intentions. During these demonstrations at times when the agitation-froth process was working to its best purpose and effect, the agitators and the first spitzkasten were producing and separating the agitation-froth. The tailings from the

first spitzkasten were not treated by further agitation, but were merely exposed to air and allowed to come gently to the edge or surface of the body of still water in the second, third, and fourth spitzkasten; and on these last three spitzkasten my opinion is that such float as was obtained was due merely to the oiled needle effect.

These last three spitzkasten to which I have referred have been described in evidence. They do not enter into the plant used for carrying out the process of the patent in suit as described in that patent.

Thus, these last three spitzkasten showed the oiled needle effect while the first spitzkasten at such times as the agitation-froth process was properly in operation showed the agitation-froth.

115 X Q. Is the apparatus referred to in your last answer the same apparatus as referred to by the witness, Mr. George A. Chapman, in his reply to Question 54, and if so, will you either describe that apparatus in words or if you can produce a drawing illustrating it?

459 A. The apparatus referred to is the same apparatus as referred to by Mr. Chapman in his reply to 54 Q. I produce a drawing illustrating it.

The Commissioner notes that the witness produces a drawing marked "General Plan and Section of Slimes Treatment Plant."

By Mr. Williams: The drawing referred to is offered in evidence and marked "Complainants' Exhibit Drawing Australian Model Plant."

116 X Q. Will you please state the date of the suit of British Ore Concentration Syndicate Limited against Minerals Separation Limited during which the demonstrations we have discussed took place?

A. The action commenced on the 10th of July, 1908, and the demonstrations so far as I recollect took place a few days previous to the commencement of the action.

117 X Q. You have stated that in 1902 the Elmore Bulk Oil Process was the only one publicly known or tried on a commercial scale. Was not a process tried at Denver, Colorado, some time in the year 1889, and reported in public newspapers, this process being reported as utilizing oil for the flotation of sulphuret (sulphide) and chloride of silver?

A. You have handed me a photograph of an extract from "The Daily Herald Democrat," of Leadville, Colorado, dated Wednesday, October, 1889, and the extract states that experiments are be-

460 ing made with a bulk oil process for the concentration of dry silicious ores.

118 X Q. Is it not a fact that upon November 15th, 1890, the "Engineering and Mining Journal" published an account of certain oil concentration operations stated to have taken place at Baker City, Oregon?

A. Yes.

By Mr. Williams: The two photographs produced by Defendant's Counsel, are, with his consent, offered in evidence.

The publication first referred to is marked "Complainants' Exhibit

Fryer Hill Publication," and the other one is marked "Complainants' Exhibit Criley and Everson Publication."

119 X Q. Is it not a fact that when sulphuric acid is added to water, say in a test tube, it will combine with the water and will not form a layer upon the water?

A. Yes, the sulphuric acid dissolves in the water.

120 X Q. So it would hardly be practicable or intelligible to describe the amount of sulphuric acid to be added to water in a test tube by stating that enough sulphuric acid was added to form a layer, or a thin layer?

A. No.

121 X Q. You have said that if Fromont's process were carried out in a Gabbett mixer in such a way as to beat air into the mixer the operation would be quite inconsistent with the Froment pro-
461 cess. If Froment's process were to be carried out in the apparatus shown in the Froment plan, using Froment's agitating or mixing vessel with the two agitators revolving at 300 revolutions per minute and this were to result in beating in air, would this be inconsistent with Froment's process?

A. I have not made this statement contained in the first part of your question. The apparatus shown in the "Froment plan" is intended to be used in the manner described in the "Froment Description." The operations set forth in the Froment description constitute the method and the only method known to me in which Mr. Froment intended that his process should be reduced to practice. The Froment apparatus comprises several parts, two of which are the most important, namely, the centrifugal mixing device and the vat with coil. The only method of using the centrifugal mixing device on the one hand, or the vat with coil on the other hand, consistent with Froment's process, is the method set forth in the "Froment's Description." The method of using the vat with coil is fundamental to the Froment process. The vat with coil is filled with water, at the bottom of which is a mass of ore in which the little oily masses containing the sulphides are imprisoned. At this stage carbon dioxide gas is generated in a nascent state in this mass at the bottom of the vat, the intention being that the bubbles of carbon dioxide, as they are generated, shall attach themselves to the little oily masses and buoy them to the surface. This generation of carbon dioxide gas takes
462 place immediately, the sulphuric acid comes in contact with the calcite. If a Gabbett mixer were to be used at this stage of the Froment process so as to beat in air, say for two and a half minutes, this would be utterly inconsistent with the Froment process and would be entirely destructive of the Froment phenomenon. Froment having given clear instructions that the mass of ore containing little masses of oil and sulphides is to be introduced into a vat which is filled with water, and that carbon dioxide gas is to be generated, that is to say, produced into a nascent state in that sunken mass so as to allow the nascent bubbles of carbon dioxide to attach themselves to these oily masses, and Froment having made it clear that this sunken mass is to be slowly turned over at the bottom of the

vat to allow the oily masses and attached bubbles of carbon dioxide to escape and come to the surface, a metallurgist who would replace this operation by a violent agitation such as is employed in the agitators of the agitation-froth process would be deliberately departing from Froment's instructions, be deliberately destroying the essential part of the Froment process, and would, in my opinion, be doing something deliberately misleading and unfair.

On the other hand, if in the Froment process as described in "The Froment Description," a metallurgist were to replace Froment's centrifugal mixing device by a Gabbett mixer which introduced air in large quantities, he would not, in my opinion, be doing any-
463 thing inconsistent with the Froment process, and this is what my clients did, with the full knowledge of what the Froment process was. Or, if Froment's centrifugal mixing device were used as described in the "Froment Description," and if air were beaten into the centrifugal mixing device, as in my opinion it would be, this would not be inconsistent with Froment's process, but would and does constitute the first step of the Froment process.

122 X Q. Were Messrs. Sulman, Picard and Ballot present at the demonstrations which were made by Minerals Separation, Limited, in the presence of representatives of the complainants during the progress of the suit brought by the British Ore Concentration Syndicate, Limited, against Minerals Separation, Limited, the demonstrations referred to being those I have previously made enquiry of you about.

A. I do not remember; but I think that Mr. Sulman was present during part of the time.

123 X Q. When the Froment description and the Froment plan were first seen by you were they accompanied by translations of the description and of the writing upon the Plan, these being in French as I understand it, in the original?

A. Yes. At the end of 1903, the originals were received by my firm and translated by our chief translator, Mr. Mark Lvoff. They were then sent to Mr. Ballot with the translations and when I said that I checked the translations with the originals I meant that I did so within the last month in order that I might be able to testify that the translations were correct.

464 124 X Q. In what countries is the process set forth in Froment's British Patent 12,778 of 1912, protected by Letters Patent?

A. In England and Italy, I believe.

125 X Q. You are quite positive are you not that the Froment process is not patented in any other country than England and Italy?

A. At the end of 1903, I made a search to see whether any other patent applications had been made by Mr. Froment except those in England and in Italy and I found no others. I also heard from Mr. Froment indirectly that he had not made corresponding applications in any other countries.

126 X Q. Is Mr. Froment alive at the present time?

A. I am informed by Mr. Zanardo that he is dead.

127 X Q. Were you present when certain demonstrations of a flotation process were made on behalf of Minerals Separation, Limited, before the officials of the German Patent Office?

Mr. Williams: Objected to as irrelevant and immaterial and not warranted by the direct examination.

A. I was.

128 X Q. Tests were made at that time, were they not, using different quantities of oil?

A. Yes. The agitation-froth process and the Cattermole process were both demonstrated.

129 X Q. What quantities of oil were used in these tests of these two processes?

465 A. The quantities respectively recommended in the Cattermole Patent and the Patent in Suit.

130 X Q. I presume that these demonstrations with different quantities of oil were made for the purpose of illustrating the difference between the Cattermole process and the flotation effect?

A. Yes, to show the difference between the Cattermole process and the agitation-froth process.

131 X Q. Was the result of these demonstrations such as to induce the officials of the German Patent Office to grant a Patent on what you term the Agitation-froth Process?

A. The Patent Application had already been allowed, after the process had been thoroughly explained and I think demonstrated to the Patent Office Examiners. The demonstrations at which I was present were made in connection with an opposition made by Elmore to the grant of the Patent. In the Opposition before the Application Department the whole question whether the patent application on the agitation-froth process should be allowed in the light of the earlier General Patent of Elmore was gone into and discussed in the minutest detail in arguments lasting several months, and the Application Department decided that the agitation-froth process was entirely distinct from the Elmore process, and at this stage the opposition failed. On appeal there was a hearing at which I was present

466 lasting for an hour or two, before a tribunal of five gentlemen, who in my opinion, had not the remotest idea of what we were talking about. Evidence was actually given to the tribunal by the opponents during the argument, without even an offer to the Applicants of leave to deal with that evidence, and the Appeal Department reversed the Decision of the Application Department. I need hardly say that this procedure did not incline me to the view that the agitation-froth process has the slightest resemblance to the Elmore process. The final result of these proceedings therefore was that a German Patent was not granted on the agitation-froth process.

132 X Q. In the suit of the British Ore Concentration Syndicate, Limited, against Minerals Separation, Limited, referred to previously by us, Mr. Bertram Blount testified as follows, referring to the second example given in the Everson Patent:

"2102. What have you done with regard to the second ex-
" ample?—I pursued the same course. I followed the prescription
" as faithfully as possible, and I tried it on several ores. I have got
" five before me, Broken Hill Crude Ore, Broken Hill tailings, galena,
" calco pyrites and zinc from Belgium.

"2103. Did you get effective concentration?—Very good. In
" some cases I got a high concentration.

"2104. Will you give one instance—the best instance?—
467 " The best instance that I can give is the Belgian zinc ore.
" The metal in the ore was 10,9 per cent.; that is the original
" ore. That is a poor ore. I can go at once to the recovery of metal
" from that ore. The percentage of concentrates was 38,5 per cent.;
" one-tenth of the metal we got out, but in a concentrated form. As
" to the concentrates itself the recovery was low, but the metal had
" risen from 10,9 per cent. in the original to 38,5 per cent. in the
" concentrates. It is not necessary to stop at a single operation. It
" could be repeated and the amount of concentrates thereby increased.

"2105. But the degree of concentration was high? Yes. If I
" may take another illustration, galena, where I raised the whole
" content of the original ore, which was 50 per cent., up to 76,8 per
" cent. at a single operation, and recovered at that single operation
" 61 per cent. of the total metal in the ore. That was galena.

"2106. Did you find that you succeeded in washing away the
" sandy or the gangue particles as she describes? Yes, they came
" away. The gangue, as it came away from the mass, which had
" been well triturated with water, was white and clean.

"2107. You have seen this description given of this specification
" in the 'Engineering and Mining Journal'? Yes.

"2108. Do you find it is substantially correct? Allowing for the
" picturesqueness of the lay reporter, I think it is very good."

468 I understand that Mr. Blount in giving this testimony did so as an expert witness for the defendant, Minerals Separation, Limited, and I ask you whether your statement previously made in this deposition expresses your conclusion, notwithstanding Mr. Blount's testimony above quoted?

By Mr. Williams: The question is objected to for the reason that it places upon the record of this suit, without proper proof, thereof, a mere fragment of a proceeding, which as appears from the printed record from — this testimony was quoted, — a long trial with a printed record of 445 pages.

A. Yes.

133 X Q. Did you have any consultations with Mr. Blount prior to his giving the testimony above quoted?

A. I was present at many consultations connected with the suit, and Mr. Blount was sometimes present.

134 X Q. At that time did you disagree with Mr. Blount, as you apparently do now, upon the interpretation of the Everson patent or upon the possibility of working the process set forth therein?

A. I took no part in the tests referred to by Mr. Blount, and can-

not testify as to them; for that reason I could not criticise Mr. Blount's tests and did not discuss them with him. In my answer to 22 Q. I have stated that in using the second example of the Everson process in many cases I succeeded in getting the oil with
469 some sulphides in it to float off as the water overflowed. This was my experience prior to the date of Mr. Blount's evidence and also subsequently. It is not for me to say whether my experience is in disagreement with Mr. Blount's views.

135 X Q. Frequent mention has been made during the progress of the testimony in this suit by the witnesses, including yourself, to Mr. Theodore J. Hoover, formerly General Manager of Minerals Separation Limited. Have you interviewed Mr. Hoover with a view to ascertaining whether his testimony could be secured to illuminate the matters in connection with which his name has been mentioned?

A. No.

136 X Q. Have you interviewed him for any purpose since the taking of evidence in this suit commenced?

A. Yes.

137 X Q. Did you express to him any desire that he should or should not testify in this suit?

A. I informed Mr. Theodore J. Hoover that one of the objects of the present Commission was stated to be that he, Mr. Theodore J. Hoover, should be called as a witness on behalf of the defendant, whereupon Mr. Hoover expressed the greatest astonishment, and volunteered the statement that he could not and would not testify on behalf of the defendant in this suit.

I expressed to Mr. Hoover my agreement with him in his attitude, but beyond that I expressed no desire.

Cross-examination closed.

470 Redirect examination.

By Mr. Williams:

138 R. D. Q. Was the interview with Mr. Theodore J. Hoover of which you have testified at your solicitation?

A. Certainly not.

139 R. D. Q. You have said that Mr. Hoover said that he could not testify on behalf of the defendant in this suit. Can you shed any light on the exact meaning of that expression, as a consequence of your talk with him?

A. Yes. Mr. T. J. Hoover stated that one reason why he could not testify against the Minerals Separation Limited was that he had been their manager and at all times an enthusiastic believer in the agitation-froth process. He also stated that he now wished to take no personal part in patent litigation, and he also expressed himself to me as very indignant at much of the evidence given on behalf of the defendant in this suit.

By Mr. Scott: Entire answer is objected to as being hearsay testimony in that it admittedly consists of nothing other than a repeti-

tion of statements alleged to have been made by a third party, who has not been produced for examination.

By Mr. Williams: It is submitted that the question and answer are fully warranted by the cross-examination, particularly 137 X Q.

140 R. D. Q. I call your attention to 67 X Q. and your
471 answer thereto and ask you why you are not prepared to repeat the demonstration which defendant's counsel attempted to characterize in that question?

A. Because the apparatus referred to has long since been destroyed.

141 R. D. Q. The Sulman and Picard Slide Machine has been referred to in this testimony. Can you testify as to when you first had knowledge of this machine and as to anything connected with the construction by Dearden and Company of such an apparatus, and will you kindly do so?

A. To the best of my recollection, I first saw the Slide Machine at Sulman and Picard's Laboratory at the end of 1909; at any rate, I was familiar with it at the beginning of 1910. Messrs. Sulman & Picard used to call it "The Shear Gabbett" or "Shear Mixer." On the 2d of March, 1910, Messrs. Minerals Separation Limited rang up my firm and stated that they wished to have some of these Shear Gabbetts made by a regular maker of apparatus of this type. My partner, Mr. Tennant, to my knowledge, recommended that our own model maker, Mr. W. H. Dearden, should make them, and Minerals Separation Ltd. accepted my partner's suggestion.

Re-direct examination closed.

Deposition closed.

WILLIAM H. BALLANTYNE.

472 London, August 31, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

GEORGE LOCKWOOD MORRIS, a witness produced on behalf of the complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. What is your name, age, residence and occupation?

A. George Lockwood Morris; aged fifty-three; residence, 44 Tregunter Road, South Kensington, London, S. W.; Office Manager of The Anglo Continental Import and Export Company, 62 and 63 Basinghall Street, London, E. C.

2 Q. During the latter part of 1909 and early 1910, what was your occupation?

A. I was general manager of the Emu Smelting Works, near Swansea in South Wales.

3 Q. While you were thus employed, was a plant installed for the concentration of ores, and if so, by whom?

A. Yes, by the Minerals Separation Limited.

4 Q. Without asking you particularly as to details, but simply as to general appearances, do the drawings "Complainants' Exhibit Drawing of 1909 and 1910 Agitation-Froth Plants" represent this plant so installed?

473 A. As far as I can see it seems identical.

5 Q. For what purpose was this plant used?

A. For producing concentrates for zinc smelting purposes.

6 Q. What ore was concentrated in this plant?

A. Ore sent by the San Francisco Del Oro Mine, Mexico.

7 Q. Was this concentration plant in your charge?

A. No.

8 Q. In what form did the concentrates appear in the spitz boxes and in what form were they delivered for the smelting furnaces?

A. In the spitz boxes they appeared to me to be all of a froth and were delivered to me as a wet powder.

9 Q. About what quantity of concentrates, in total amount, were delivered for smelting purposes by this concentration plant?

A. Approximately about 120 tons.

10 Q. Were, or were not, these satisfactory concentrates for this smelting operation?

A. Yes, they were satisfactory for the smelting operation.

11 Q. What in general was the character of the smelting operation or what process of smelting was employed?

A. It was the Picard Briquetting Process.

Direct examination closed.

474 Cross-examination.

By Mr. Scott:

12 X Q. Did you see the operation of the flotation plant frequently at Emu?

A. Yes, I saw it frequently.

13 X Q. Probably almost every day, if not every day?

A. Probably.

14 X Q. Did you take an interest in the flotation plant, or was your observation merely casual?

A. I had no time to take much interest in it.

15 X Q. Did you frequently observe the material in the spitz boxes?

A. Occasionally.

16 X Q. I presume you made no point of looking at the contents of the spitz boxes with any particular frequency or regularity, did you?

A. No.

17 X Q. Upon every occasion when you observed the contents of the spitz boxes, that is when the plant was in operation, was the liquid in the spitz boxes completely covered with froth?

A. To the best of my recollection, yes.

18 X Q. Was your interest in this particular part of the plant sufficient to enable you to remember at this date, with certainty, that the liquid in the spitz boxes when the plant was in operation, was always covered when you saw it with a foaming froth, as distinguished from a thin film?

475 A. My interest would have been only sufficient during the latter part of the operation.

19 X Q. Did you keep in touch with the operation of the flotation plant sufficiently to know whether different kinds of oil were used at different times?

A. I cannot say. I believe different oils were at the works, but whether they were used, I cannot say.

20 X Q. I do not suppose that at this time you have any definite recollections of the manner in which the flotation plant was working on the 23d and 24th February, 1910?

A. I could not say.

21 X Q. Do you remember of meeting Mr. Hyde at the Emu Plant?

A. I do remember the gentleman coming down there.

22 X Q. He came down with Mr. T. J. Hoover, did he not?

A. Yes.

23 X Q. I do not suppose you now can remember whether the liquid in the spitz boxes was or was not covered with a froth as distinguished from a mere thin film upon the days when Mr. Hyde was at Emu?

A. No.

24 X Q. About what was the capacity of your smelting plant at Emu?

A. We used to smelt about 4 tons of concentrates in the furnace per day.

25 X Q. Were there periods of, say a week or more, when
476 you operated the smelter continuously at the rate of four tons per day?

A. Yes.

26 X Q. What was about the longest continuous period, according to your recollections, that you operated the smelter at the rate of four tons of concentrates per day?

A. I never stopped once I commenced. To treat this tonnage would take about thirty days.

27 X Q. Was the plant, including both the flotation and smelting sections, operated as a money-making enterprise or for the purpose of experiment?

A. The smelting process was to prove a commercial success; the flotation I do not know anything about.

28 X Q. So far as your observation went, the flotation plant was operated merely for the purpose of supplying concentrates for the smelting plant, was it not?

A. Yes, as far as I am concerned.

29 X Q. Do you know whether the flotation plant at Emu has

ever been operated since the occasion when you were connected with that plant?

A. It has not been operated since.

30 X Q. Is the flotation plant still in existence?

A. No.

31 X Q. Do you know whether it was removed to some other locality or destroyed?

A. It was destroyed.

32 X Q. Did you desire to have any particular grade of
477 concentrates—that is, grade of purity—delivered to you by the flotation plant for use in the smelting operations?

A. No.

33 X Q. About what grade of purity did the concentrates delivered from the flotation plant run?

A. To the best of my recollection, about 3 per cent. of what we call insolubles there, gangue.

34 X Q. Were analyses made and reports submitted upon the purity of these concentrates?

A. I did not see the Minerals Separation assays, but we had our own assayer, who reported occasionally.

35 X Q. Do you know what percentage of the metal or metals in the ore were recovered from the crude ore operated on by the flotation plant?

A. No.

36 X Q. Do you know, in a general way, whether the recovery of metals from the crude ore by the flotation plant was high or low?

A. I could not say; I saw no figures.

37 X Q. I presume you were not interested in the percentage of recovery of metal or metals from the ore so long as a concentrate of sufficient degree of purity was delivered to you for your smelting operations?

A. That is quite correct.

Cross-examination closed.

478 Redirect examination.

By Mr. Williams:

38 R. D. Q. What was done with the products of the smelting furnace? Were they sold?

A. They were sold.

39 R. D. Q. In 32 X Q. you were asked whether or not you desired to have any particular grade of purity in the concentrate. Excluding any question as to the proportions of the different metals present, and confining your answer to the amount of insolubles, I would now ask you whether or not you did not desire to have at least a certain grade of purity as to the percentage of insolubles in the concentrates delivered to the smelting furnace?

A. I told them what I should like, but my business was to smelt what they gave me.

40 R. D. Q. And, so far as percentage of insolubles was concerned, was or was not what they gave you what you wanted?
A. It was.

Redirect examination closed.

Recross-examination.

By Mr. Scott:

41 R. X Q. Do you know what these insolubles were in the concentrates; that is, what mineral?
A. I could not remember now.

Deposition closed.

GEO. L. MORRIS.

479 ALLEN CRAWFORD HOWARD, recalled as a witness for the complainants, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. Are you the same Allen Crawford Howard who has heretofore testified herein?
A. I am.
2 Q. I now show you three sheets of drawings, and ask you whether or not these drawings represent the large scale testing apparatus in use in the London works of Minerals Separation, Ltd., when Mr. Hyde returned to London, in December, 1910, and described by you in your answers to 31 to 34 Q., inclusive, in your former deposition in this suit?
A. Yes.
3 Q. Please very briefly describe thes drawings as to the parts lettered thereon.
A. A are the agitation boxes numbered from 1 to 8 in the order in which they operate upon the pulp. B are the frothing-boxes numbered from 1 to 5 in the order in which they receive the pulp. C are the pipes from the bottom of one spitzkasten up to the bottom of the next agitating-box, respectively, through which the pulp or residue from the spitz-box is drawn upward by the action of the rotating agitator as a pump. E are the openings from the agitation-box to spitzkasten, each having an inner lining consisting of a brass pipe or bushing. F are the flaring deflecting mouths. G are the rotating
480 agitators, which are carried by the frame-work H. These drawings were made from the working drawings of the plant and are substantially accurate in all dimensions.

By Mr. Williams: The drawings referred to and described by the witness are offered in evidence as "Complainants' Exhibit King John's Court Standard Plant," it being noted that they are on three sheets, that sheet 1 is a sectional and elevation, sheet 2 a side elevation, and sheet 3 a plan.

4 Q. Please state whether or not the drawings "Complainants' Exhibit Drawing of 1909 and 1910 Agitation-Froth Plants" were also made from the working drawings and are substantially to scale?

A. They were, and they are.

Direct examination closed.

Cross-examination.

By Mr. Scott:

5 X Q. How are you able to remember the date when the plan for the Slide Machine was completed, that is what means have you for fixing the date?

By Mr. Williams: The witness having testified to this fact in his former direct examination and having been cross-examined thereon, and the cross-examination closed, objection is made to this question as improper cross-examination at the present time.

481 A. I fix the time by the fact that I was supervising the draughtsman who was tracing Mr. Hoover's plan of this Slide Machine at the time when Mr. Hoover called me into his office to introduce Mr. Hyde to me.

6 X Q. Have you any memorandum that enables you to recollect positively that the plan of the Slide Machine was completed before Mr. Hyde arrived in London?

A. I have no such memorandum.

7 X Q. Have you any knowledge as to how long Mr. Hyde had been in London at the time Mr. Hoover called you in and introduced you to him?

A. It is manifestly impossible for me to testify as to Mr. Hyde's movements before I saw him.

8 X Q. Is the plan of the Slide Machine still in existence?

A I am unable to say whether the original plan of the Slide Machine is in existence.

9 X Q. Do you know whether any other plan of the Slide Machine is in existence?

A. There is probably in existence a plan of the Slide Machine as it is now constructed, that is showing the minor alterations which have been made since the order was first placed with W. H. Dearden & Co.

10 X Q. When did you last see the original plan of the Slide Machine?

A. That I am quite unable to say.

11 X Q. Did you make a search among the various plans for the Slide Machine in order to correctly fix the date of the original plan before appearing as a witness?

482 A. No.

12 X Q. Have you refreshed your memory from any record or memorandum of any kind as to the date when the original or other plans for the Slide Machine were made?

A. I have not.

13 X Q. You have a distinct recollection have you that at the time when you were introduced to Mr. Hyde work was in progress on the plans for the Slide Machine?

A. I have already stated that I fix the time by the fact that I was supervising the draughtsman who was tracing Mr. Hoover's plan of this Slide Machine at the time when Mr. Hoover called me into his office to introduce Mr. Hyde to me.

14 X Q. What sort of information, sketch or memorandum did the draughtsman use as the basis of his original plan of the Slide Machine?

A. As I have already stated, the original plan of the Slide Machine was made by Mr. Theodore J. Hoover himself. This plan was drawn to scale in pencil and was merely traced by the draughtsman referred to.

15 X Q. And are neither the original drawing made by Mr. Hoover, the tracing made by the draughtsman nor reproductions from said tracing now in existence to your knowledge?

A. They are not in existence to my knowledge.

16 X Q. Have you made any search or investigation to enable you to say they are not in existence?

483 A. I have made no such investigations.

17 X Q. So far as you know now I presume it is possible that either Mr. Hoover's original drawing, the tracing made by the draughtsman or a reproduction thereof might still be in existence and might bear a date showing when they were made?

A. As I do not know whether they are in existence I am unable to testify on the point.

Cross-examination closed.

Redirect examination.

By Mr. Williams:

18 R. D. Q. Will you make a careful and thorough search for the drawings enquired of and produce them for the inspection of counsel if they are found?

A. I will do so.

Redirect examination closed.

Deposition closed.

ALLEN CRAWFORD HOWARD.

Adjourned to Monday, September 2, at 10:30 A. M. at the same place.

484 London, September 3, 1912.

PERCY LOT YOUNG, a witness produced on behalf of the complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. State your name, age, residence and occupation?

A. Percy Lot Young, age forty-one, mechanical engineer; I am manager on the mechanical side of H. Young & Co., Ltd., Nine Elms Iron Works, London, S. W. I reside at Putney, London, S. W.

2 Q. How long have you been connected with H. Young & Company?

A. Since 1887.

3 Q. Has your concern manufactured a mixing device?

A. Yes.

4 Q. Under what patents or patent did you work in the manufacture of this mixing device?

A. The Burt, Boulton & Haywood and E. R. Gabbett's Patent. We were the sole manufacturers.

5 Q. I now show you British Patent No. 840 of 1889 and ask you whether or not that is the patent to which you have referred?

A. That is the one?

6 Q. When did your concern commence to manufacture this mixer?

485 A. In 1890.

7 Q. And how long have you continued to manufacture it?

A. We are still manufacturing it, and there is still a demand for it.

8 Q. Will you kindly produce a reproduction of the first advertising matter which you used in connection with this Gabbett mixer?

A. I now produce it and I may say that in June, 1890, these were the first circulars ordered to be printed, and circulated.

9 Q. Generally about how long did you continue to advertise this mixer with such advertising matter as appears in the circular which you have produced?

A. Until this first imprint was exhausted. I should say about two years, or three years.

10 Q. Then what change did you make in the pictorial part of your advertising matter?

A. We found that at The Brewers' Exhibition that we were giving away too much information. Also, that people misunderstood the effect of the cone in looking at the other details. We therefore changed it by leaving out the baffles from the illustration, as is shown in the advertisement which I now produce. We no longer gave a section of the cone, but an outside view.

11 Q. The advertisement that you have produced is in the Journal of the Society of Chemical Industry issue of November 30, 1897.

Do you happen to know whether or not this journal has a
486 wide and international circulation?

A. I believe it has a wide circulation.

By Mr. Williams: The circular first produced by the witness is offered in evidence as "Complainants' Exhibit Young First Circular."

The advertisement in the Journal of the Society of Chemical Industry of November 30, 1897, is offered in evidence as "Complainants' Exhibit Young Advertisement A," it being noted that this advertisement is on the cover of that Journal.

12 Q. I now show you an advertisement in "Engineering" in the issue dated January 3, 1902, and appearing on page 57 thereof, and ask you if you recognize that as one of the advertisements of your firm?

A. Yes, I do recognize it.

By Mr. Williams: The advertisement referred to is offered in evidence as "Complainants' Exhibit Young Advertisement B."

13 Q. By what name was this mixer known?

A. It was known as "The Rapid Mixer," and I may say as a Cone Mixer.

14 Q. And without attempting to particularize, please state whether or not this cone mixer was advertised to a considerable extent?

A. It was. I can instance "The Brewers' Journal," "The Engineer," "Engineering," "The Journal of the Society of Chemical Industry."

487 15 Q. When you made this cone mixer with a vessel of round or cylindrical form did you customarily provide any stationary means within the vessel and if so, what did you provide?

A. If we supplied the vessel baffles would be provided, but many clients bought the cone and adapted their own vessels to our instructions, which were the insertion of baffles.

Direct examination closed.

No cross-examination.

Deposition closed.

PERCY L. YOUNG.

London, September 4, 1912.

ROBERT MOLESWORTH KINDERSLEY, a witness produced on behalf of the complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. Please state your name, age, residence and occupation?

A. Robert Molesworth Kindersley; age, forty; residence, Langley

House, Abbots Langley, Hertfordshire; banker, partner in the firm of Lazard Brothers & Company.

2 Q. Has your firm Lazard Brothers & Company been
488 interested in any ore concentration operations with Minerals Separation Limited, one of the complainants in this suit.

A. Yes.

3 Q. Please state briefly what these operations have been?

A. We entered into an agreement with the Minerals Separation Company to find the capital to erect a plant for dealing with tailings, etc., in the Broken Hill district of Australia and to find the capital for purchasing such tailings, on the understanding that the Minerals Separation Company were to organize such plant and that the Minerals Separation Company and ourselves were to share the profits resulting from the treatment of these tailings. There were three ventures of this description. The first may be termed the Original Joint Venture. The second, the Triple Venture and the third the South Blocks Venture. From No. 1 a total profit of £130,341 8. 10. was secured £65,170.14 5. of which went to Lazard Brothers & Company and a similar amount to Minerals Separation Company.

In the case of the second or Triple Venture, a profit of £51,024, 11. 11. was secured, one half of which went to the Sulphide Corporation Limited and the other half of which was divided between the Minerals Separation Company and my firm Messrs. Lazard Brothers and Company.

In the case of the third Venture the total profit was £321.
489 5. 0. which was divided equally between my firm and the Minerals Separation Company.

The total profit of these three ventures was £181,687.5.9.

I produce two tables showing the profits and also the material treated and results obtained. These tables have been carefully prepared and I believe them to be substantially accurate. It is my understanding that the process used was the agitation-froth process and the tables are so entitled.

By Mr. Scott: The last sentence of the answer is objected to as being based upon hearsay it not appearing that the witness has any personal knowledge as to whether the concentrates referred to were produced as an agitation-froth so called, a froth of any kind, or by what has been termed "the greased-needle effect."

By Mr. Williams: The two tables produced by the witness are offered in evidence and marked respectively "Complainants' Exhibit Statement of Profit Lazard Ventures" and "Complainants' Exhibit Table of Material and Results Lazard Ventures."

Direct examination closed.

Cross-examination.

By Mr. Scott:

4 X Q. Do you know whether MineralsSeparation, Limited,
490 has ever paid a dividend to its shareholders and if you do what is the fact of the matter?

A. I believe, to my knowledge, not. Their profits have always been used in furthering the ends of the Company.

Cross-examination closed.

Deposition closed.

R. M. KINDERSLEY.

FRANCIS AMBOOR KEATING a witness produced on behalf of the Complainants having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. What is your name, age, residence and occupation?
A. Francis Amboor Keating, I am upwards of twenty-one years of age, my residence is 15 Rutland Gate, London, S. W., Merchant.
2 Q. What is your connection with the Sulphide Corporation?
A. I am a Director.
3 Q. Is the Sulphide Corporation a licensee of Minerals Separation, Ltd., one of the Complainants in this Suit?
A. Yes.
4 Q. About how long a period has the Sulphide Corporation been such licensee?
491 A. About six years.
5 Q. Please summarise the work that has been done by the Sulphide Corporation in the concentration of ores under this license?
A. We have treated one million, one hundred and seventy-six thousand, nine hundred and thirty-four tons of tailings from our dumps and from our lead mill, up to June 30th last, yielding 445,299 tons of zinc concentrates at an average cost of eight shillings and five pence per ton, and an average profit of eleven shillings and one penny per ton, realizing thereby a total profit of £650,153.
6 Q. Where were these operations carried out?
A. Central Mine, Broken Hill, Australia.

Direct examination closed.

Cross-examination.

By Mr. Scott:

7 X Q. Have you ever been at Broken Hill, Australia?
A. Yes, frequently.
8 X Q. With what particular business are you connected as a merchant?
A. I am a partner in the firm of Gibbs, Bright and Company.
9 X Q. With what business are Gibbs, Bright and Company engaged?
A. Shipping and general mercantile business.
10 X Q. Is the firm of Gibbs, Bright and Company or any of its

members besides yourself, interested financially in the Sulphide Corporation?

492 A. The firm, as a firm and their London House, Messrs. Antony Gibbs & Sons, are both very large share holders in the Sulphide Corporation.

11 X Q. Are Gibbs, Bright and Company, or Messrs. Antony Gibbs & Sons, or any of the members of either of those firms financially interested directly or indirectly in Minerals Separation, Limited?

A. Both firms hold shares in Minerals Separation, Limited.

12 X Q. Do the members of either of these firms individually hold any shares in Minerals Separation, Ltd., aside from the interest of the firms to which you have referred?

A. To the best of my knowledge, they do not.

13 X Q. Do either of the firms you have mentioned, or the members thereof control the voting of any of the shares of Minerals Separation, Limited, or of the Sulphide Corporation, other than the shares which they actually own?

A. No; not to my knowledge.

14 X Q. Have either of these firms or the members thereof ever held proxies to vote shares of Minerals Separation, Limited, or the Sulphide Corporation?

A. Not to my knowledge.

15 X Q. Are any of the members of Antony Gibbs & Sons or of Gibbs, Bright & Company, Directors in Minerals Separation, Limited?

A. No.

493 16 X Q. Have they ever been?

A. No, never.

17 X Q. Are any of the Directors, or stockholders or shareholders of Minerals Separation, Limited, so far as you know, shareholders in the Sulphide Corporation?

A. Beyond the fact that Antony Gibbs & Sons and Gibbs, Bright & Company own shares in Minerals Separation, Ltd., and also in the Sulphide Corporation, I do not know whether there are other cases or not. There are, I think, something like 2,000 shareholders in the Sulphide Corporation.

18 X Q. Is Mr. Francis Gibbs, Junior, a Director of Minerals Separation, Limited, or has he ever been?

A. I believe he is now.

19 X Q. Is Francis Gibbs, Junior, a relative of any of the members of either of the firms you have referred to?

A. He is a cousin of some of the partners of Anton Gibbs & Sons.

20 X Q. Francis Gibbs, Junior, is a Director in Minerals Separation, Limited, as the representative of the interest in that company controlled by Antony Gibbs & Sons and Gibbs, Bright & Company, is he not?

A. I do not think so. He is now employed with the firm of Messrs. Lazard Brothers, who are shareholders in Minerals Separation, and if he represents any interest, I should imagine he represents theirs.

21 X Q. Do you know whether the shares in Minerals Sepa-

494 ration, Limited, owned by Antony Gibbs & Sons and by Gibbs, Bright & Company, were voted for Francis Gibbs, Junior, as a director of Minerals Separation, Ltd.?

A. I do not think that they voted at all, as Mr. Gibbs' election was unanimous.

22 X Q. Were you present at the election of Mr. Gibbs as a Director of Minerals Separation, Limited?

A. No, I am pretty sure I wasn't.

23 X Q. Is it not a fact that Antony Gibbs & Sons and Gibbs, Bright & Company and Lazard Brothers & Company, together, own the controlling interest in Minerals Separation, Limited?

A. I do not know what Lazard Brothers hold in this, and therefore I cannot say whether they hold a controlling interest.

24 X Q. But they hold a very large proportion of this interest, do they not?

A. They are large shareholders.

Cross-examination closed.

Deposition closed.

F. A. KEATING.

495 ALLEN CRAWFORD HOWARD, recalled as a witness for the complainants, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. Are you the same Allen Crawford Howard as has heretofore testified herein?

A. I am.

2 Q. You were asked to make a search for drawings of the Slide Machine? Have you done so, and have you found the original plan?

A. I have done so, and I have not been able to find the original plan.

3 Q. What have you found as to the original plan?

A. I have found the original tracing referred to in my testimony which I now produce.

4 Q. And I take it that you have not found the pencil drawing made by Mr. Hoover from which this drawing now before you was traced. Is that correct?

A. The pencil drawing made by Mr. Hoover is the original plan which I have stated I have searched for, but have been unable to find.

5 Q. In your answer to 5 X Q. in your second deposition you say that you were supervising the draughtsman who was tracing Mr. Hoover's plan of the Slide Machine, when Mr. Hoover called you into his office to introduce Mr. Hyde to you. Please state whether or not you identify this tracing, now produced, as the tracing referred to by you in that answer?

A. I identify it as that tracing.

496 6 Q. Is there anything upon the tracing itself, as, for example, the words "Drawing No. 100," which enables you to fix the date?

A. There is nothing on the tracing which enables me to fix the date.

7 Q. Please state whether or not this occasion, when the draughtsman was making the tracing which is now before you, and you were called into Mr. Hoover's office to be introduced to Mr. Hyde, was the occasion of Mr. Hyde's first visit to the office of Minerals Separation, Limited?

A. It was.

8 Q. Did you do anything in connection with an effort to find a suitable model maker to make this machine, and if so, what did you do?

A. I visited several manufacturing engineers, but I did not find a firm who satisfied me.

By Mr. Williams: The drawing produced and identified by the witness is offered in evidence as "Complainants' Exhibit First Tracing Slide Machine."

9 Q. You have testified that there was probably in existence a plan of the slide machine as it is now constructed. This was in answer to 9 X Q. Have you found that plan?

A. I have found a tracing showing the modified form of the slide machine as it is now made, and now produce it.

497 10 Q. I note that this tracing has upon it "Drawing No. 101," and no date. Does the number enable you to fix the date when it was made?

A. The number does not enable me to fix the date when it was made.

11 Q. What is your recollection as to when it was made?

A. My recollection is that this tracing was made at the latter end of March or the beginning of April, 1910.

Direct examination closed.

Cross-examination.

By Mr. Scott:

12 X Q. What is the source of your statement that the occasion on which you were introduced to Mr. Hyde was the first time Mr. Hyde had visited the offices of Minerals Separation, Limited? Are you informed as to all of the visitors to the offices of Minerals Separation, Limited?

A. I will answer the second part of the question first. Mr. Hyde was coming to London with a view to joining the staff of my company, and he cannot therefore be regarded as an ordinary visitor to the offices of my company. I had seen a cable from Mr. Hyde stating the date on which he was leaving New York, and Mr. Hoover had advised me that he expected Mr. Hyde to arrive at the office on the morning in question. Moreover, while I was in Mr. Hoover's

room, talking to Mr. Hyde, Mr. Hoover took him in to introduce him to Mr. Ballot.

498 By Mr. Scott: All of the answer setting forth statements by Mr. Hoover is objected to as hearsay.

Cross-examination closed.

Redirect examination.

By Mr. Williams:

13 R. D. Q. Are you enabled to fix the date when you were introduced to Mr. Hyde, as you have testified, and if so, will you please do so?

I hand you a cable message from San Diego, California, which has been marked for identification "Cable Hyde to Hoover, January 20, 1910."

A. The date was February 14th, 1910, and the day of the week was Monday.

14 R. D. Q. I see that I have picked up a document and shown it to you which was not the document which I particularly intended to show to you, and I therefore now show you another cable message from Palo Alto, California, dated January 24th, 1910, which has been marked for identification "Cable Hyde to Hoover, January 24, 1910," and I ask you whether an examination of this document leads to any modification of the testimony which you have given?

A. It does not lead to any modification of my testimony.

Redirect examination closed.

Recross-examination.

By Mr. Scott:

15 R. X Q. What connection is there in your mind be-
499 tween the date of either or both of these cablegrams which have been shown you and the date February 14th, 1910?

A. I did not base my testimony as to the date of Mr. Hyde's first visit to the office of my company on either of the cables referred to.

16 R. X Q. What was your statement based on?

A. The cable referred to in my answer to 12 X Q., together with my recollection of the interview.

17 R. X Q. When did you last see this cable which you refer to in your last answer?

A. I saw the cable on Monday last, and I will produce it if you require it.

18 R. X Q. And after seeing this cable, did you estimate about the period of time required to travel from New York to London, and select the date of your introduction to Mr. Hyde upon the supposition that you had been introduced to him immediately upon his arrival in London from New York?

A. I gave the matter of my introduction to Mr. Hyde my very careful consideration over the week-end, and I recollected that the oc-

casion was on a Monday morning, about the middle of February 1910, and I further recollected having seen a cable in the week before his arrival, and on reaching my office last Monday morning I called for this cable to confirm my recollection.

19 R. X Q. Then as a matter of fact, your saying Monday, February 14th, definitely as the date of Mr. Hyde's introduction
500 to you is based upon your reference to this cable announcing Mr. Hyde's departure from New York?

A. As a matter of fact your supposition is wrong, because on the following Monday, the 21st of February, I was in Christ Church, Hampshire.

20 R. X Q. How do you know that it was on a Monday you met Mr. Hyde?

A. I recollect that he told me that he had arrived on the Saturday.

21 R. X Q. How soon after your introduction to Mr. Hyde was the work of making the Slide Machine, in accordance with the tracing which you state was being made when you were introduced to Mr. Hyde, put into the hands of the model makers or machinists?

A. I should say between two and three weeks.

Recross-examination closed.

Deposition closed.

ALLEN CRAWFORD HOWARD.

Adjourned to Thursday, September 5th, 1912, at 10 o'clock, at the same place.

501 London, September 5, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

ARTHUR WEAVER WINCEY, a witness produced on behalf of the complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. Please state your name, age, residence and occupation.

A. Arthur Weaver Wincey, thirty-three, Central Mine, Broken Hill, New South Wales, Australia; Mill Superintendent of the Sulphide Corporation at Broken Hill.

2 Q. When were you last at Broken Hill, at the plant of the Sulphide Corporation?

A. I left the Sulphide Corporation plant about July 24th, 1912.

3 Q. Can you produce photographs taken by you of the flotation concentration plant of the Sulphide Corporation?

A. Yes.

4 Q. Please do so, and tell me about when these photographs were taken?

A. I now produce the photographs which were taken by me the day before leaving Broken Hill.

5 Q. Please describe these photographs in the order in which they are numbered?

502 A. Photograph No. 1 represents a photo of the flotation plant which is used for re-treating fine slimy concentrates which have been derived from the previous treatment. It also shows the connection between the spitz boxes. The plant is shown as empty.

Photograph No. 2 shows the same plant under working conditions.

Photograph No. 3 shows the same plant in which case the spitz-boxes are full of water. This photograph shows the plant as it is usually left after an operation, and particularly shows the paddles and also the level of the water in the various spitz boxes.

Photograph No. 4 is a front view like No. 3, except that the plant is at work.

6 Q. What function is performed by the paddles which are particularly shown in photographs 3 and 4?

A. The object of the paddles is to enable the concentrate to be scraped off practically free from solution.

7 Q. In what form are the concentrates in this plant?

A. The concentrates are in the form of a thick, spongy froth.

By Mr. Williams: The four photographs produced by the witness and described by him are offered in evidence and each marked "Complainants' Exhibit Sulphide Corporation Re-treatment Plant," and with the numbers 1, 2, 3, and 4 respectively.

8 Q. What other flotation concentration plants were in use at the Sulphide Corporation Works when you left there last July?

503 A. The only other flotation plant in operation at the Central Mine was that of the Zinc Section, which treats the tailings and slimes continuously as produced from the lead mill.

9 Q. Generally how did the construction of this flotation plant of the Zinc Section compare with the construction of the re-treatment plant of which you have produced photographs?

A. The only practical difference between the two plants is in the method of drive in the Zinc Section; the driving arrangement of the stirrers is operated by a pinion and crown wheel, whereas in the re-treatment plant the stirrers are driven by a belt drive. In the re-treatment plant we have no underflow pipes whereas in the Zinc Section flotation plant undereflow pipes conduct the pulp from one spitz box to the next mixer.

10 Q. In the Zinc Section flotation plant what materials, if any, are added to the pulp and what in general is the operation?

A. The pulp is delivered to No. 1 mixer where sulphuric acid and steam are added. In No. 2 mixer oleic acid or suitable agent is added and the pulp is violently agitated.

11 Q. How many mixers are there in this plant?

A. We have eight mixers in the Zinc Section plant.

12 Q. How many spitz-boxes?

A. Six spitz-boxes.

13 Q. You have said that in No. 2 mixer the pulp is violently agitated. What occurs in the other mixers?

504 A. The pulp is violently agitated in the whole of the eight mixers. The first two mixers are run at a slightly higher speed than the following six.

14 Q. Where does the pulp go from No. 2 mixer?

A. The pulp from No. 2 mixer flows through an opening in the division into No. 3 mixer and from No. 3 mixer into No. 1 spitz box.

15 Q. And from No. 1 spitz box where do the concentrates flow and where does the pulp or tailings from the first spitzkasten flow?

A. From No. 1 spitz box the concentrate is scraped off by the paddles which are arranged similarly to those shown in the photographs which have been handed in as evidence. The pulp containing the zinc and tailings sinks to the bottom of the flotation spitz box where it is conducted through a pipe into a No. 4 mixer. From No. 4 mixer it is delivered into No. 2 spitz box, and this operation continues until we reach No. 6 spitz box, where the tailings are drawn out and run to the residue vat.

16 Q. Then what is done with the concentrates from these several spitz boxes?

A. The concentrates from No. 1, 2, 3 and 4 spitz boxes are run into the concentrates settling box. The concentrates from No. 5 and 6 are returned per elevator, into No. 1 mixing box where it is re-treated with the original pulp.

17 Q. And then what is done with the concentrates from Nos. 1, 2, 3 and 4 spitz boxes?

505 A. Until just lately these concentrates were shipped direct, but a de-leading plant has been constructed in which these concentrates are treated to recover any available lead.

18 Q. You have said that the flotation plant photographed by you is used for re-treating fine slimy concentrates derived from the previous treatment. From what previous treatment are these fine slimy concentrates derived?

A. The whole of the zinc concentrates flowing from the Zinc Section Plant into the settler is treated in the de-leading plant. The slimes which flow off the concentrating tables are thickened and treated on vanners. The very finest of the slime flows off the vanners as a slimy water. This slimy water is led into thickening tanks, and from there it is delivered as feed for the retreatment flotation plant.

19 Q. You have said that oleic acid or other suitable agent is added. What is the material or agent actually used?

A. We have on various occasions used eucalyptus oil, resin oil, camphor oil, and various mixtures of the before-mentioned oils.

20 Q. What would you call the standard oily mixture?

A. The oily mixture we are using at present is that of eucalyptus and oleic acid, and we consider this gives us the best and most economical result.

21 Q. And in what proportion per ton of ore?

506 A. The amount of mixture per ton of ore is from .9 to 1.3 pounds per ton.

22 Q. And what is the average consumption of sulphuric acid per ton of ore?

A. The average consumption of sulphuric acid per ton of ore is somewhere in the neighborhood of 19 pounds.

23 Q. How long have you been in the employ of the Sulphide Corporation in connection with the flotation concentration work?

A. I started in the flotation-concentration work about June, 1906, and have been working with it ever since.

24 Q. When you started with this work, were there accumulations or dumps of tailings awaiting treatment?

A. There was, I should say, approximately from half to three-quarters of a million tons of tailings dumped from previous lead mill operations.

25 Q. What has become of these tailings?

A. These tailings have all been treated on the Central Mine in one or other of their flotation plants.

26 Q. Please name these different flotation plants?

A. No. 1 and No. 2 Flotation Plants were the original plants to treat tailings, then at a later date the Minerals Separation Plant was started which consumed tailings at the rate of 4,500 to 5,000 tons per week.

27 Q. I understand that you have named the plants which treated these tailings. Please name the other flotation plants at the Central Mine?

507 A. The Slimes Plant was erected at the Central Mine for the treatment of slimes which had been dumped separately from the tailings from the old lead mill. This plant treated about 2,000 tons per week.

28 Q. What is the present source of supply of the flotation plants first described by you, to wit, the Zinc Section Flotation Plant and the Re-Treatment Plant?

A. The feed to the Zinc Section plant is derived from the lead mill, which receives its feed from the Central Mine underground operations. The feed to the Re-Treatment Flotation Plant is obtained as previously stated.

29 Q. Are you familiar with the operations that have been conducted in all of these flotation plants?

A. Yes. At different times I have been in charge of all these plants excepting the original first two.

30 Q. In what respect, if any, have the processes carried out in any or all of these plants differed one from another?

A. The process in all these plants has been exactly the same, only in the later type modifications have been introduced to enable the saving of labor and better supervision.

31 Q. Can you give me any idea in figures of the thickness of the floating froth as shown in "Complainants' Exhibit Sulphide Corporation Re-treatment Plant Photograph 2"?

A. The thickness of the froth on No. 4 spitz box is about 7 inches.

This can be seen very easily by referring to photograph No. 3
508 where it will be noticed that the board is about three inches above the surface of the liquor; and the froth extends to within about two inches of the top of this board, which board is six inches deep.

32 Q. In photograph No. 3 I note that there is an overflow of water in the last spitz box. Is this a normal condition or if not what is its condition?

A. This overflow of water in the last spitz box is not normal condition. It is simply to show the relative water level in the flotation boxes. As noticed by this photograph the level of the water is considerably below the overflow lip of the other spitz boxes.

33 Q. I take it then that the overflow in the last spitz box is for the purpose of showing that it may overflow there without overflowing in the other spitz boxes. Is that correct?

A. That is correct.

34 Q. And as I have understood you the liquid in all of these spitz boxes is connected by the openings from spitz box to spitz box so that the fluid level is substantially the same in every spitz box of the series. This is correct is it not?

A. Yes.

Direct examination closed.

Cross-examination.

By Mr. Scott:

35 X Q. In the Zinc Section plant is any acid added at a later stage than the first mixer?

A. In usual practice all the acid is added in No. 1 mixer.

509 36 X Q. Upon some occasions is acid added in later mixers?

A. Acid has been added in other mixers but it is always considered better if we add the whole of the acid in No. 1 mixer and for that reason sometimes all the pipes are taken away so as to make it impossible for acid to be added in any other mixer.

37 X Q. In which mixer after the first was acid added when that practice was followed?

A. Pipes have been arranged for experimental work to enable us to add acid in any mixer but this has been discontinued long since, and in fact has only been used as stated for experimental runs.

38 X Q. In the operation of the zinc section plant is any oil added at a later stage of the operation than the second mixer, or has oil been added in the past at a later stage than the second mixer?

A. Oil has been added at a later stage than in the second mixer but only on very rare occasions. The usual practice being, as with the acid, to make one addition only.

39 X Q. Then the oiling of the particles is at present performed in the second and subsequent mixers?

A. Yes.

40 X Q. About what percentage of calcite does the material contain which is treated in the zinc section plant?

A. I think about one per cent.

41 X Q. I suppose it varies somewhat from time to time?

A. Yes.

510 42 X Q. Sometimes running above and sometimes running below one per cent?

A. Yes.

43 X Q. Can you state approximately what would be the maximum percentage of calcite that occurs during the variations?

A. I have no idea what the maximum is, as it may vary from time to time during the same shift, and as our samples are only taken over the shift's run I could not say what the maximum or minimum would be, but the average is very constant.

44 X Q. What is the maximum amount of calcite that you have ever known upon any occasion to be contained in the material passing through the zinc section plant?

A. Our assays are returned as CO_2 and the maximum I can remember would be about 1.2 per cent. of carbon dioxide in the ore.

45 X Q. What amount of calcite must the material have contained to yield 1.2 per cent. of carbon dioxide?

A. About 3 per cent.

46 X Q. What percentage of zinc does the material contain which is fed to the Zinc Section plant?

A. This varies from say 17 to 21 per cent. The average would be about 19 to 20 per cent.

47 X Q. In the Zinc Section plant what is the size of the agitating boxes?

A. The agitating boxes are three feet square by about five

511 feet deep.

48 X Q. And at how many revolutions per minute are the agitators operated?

A. The mixers are running at a speed of from 265 to 270 revolutions per minute.

49 X Q. Can you state about how long a time interval elapses between the entrance of the pulp into the first mixer of the Zinc Section Plant and its final departure from the same?

A. I have made tests to determine this data and found that the first particle coming through will make the trip in about five minutes but some will continue to come through after ten minutes. That is to say, in running the mixers empty and feeding in a few bags of tailings some will come out of the exit in five minutes and some will continue to come out after ten minutes so that an average between these would be approximately near the mark.

50 X Q. In the operation of any of the plants to which you have referred have you used any of the petroleum oils?

A. No, I have never used any of these in my connection with flotation although I believe they have been tested on other plants that I have been away from at the time.

Cross examination closed.

Deposition closed.

A. WEAVER WINCEY.

512 JOHN BALLOT, a witness produced on behalf of the complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination by Mr. Williams:

1 Q. Are you the same John Ballot who has heretofore testified in this suit, at the request of defendant's counsel, as a witness for the defendant?

A. I am.

2 Q. Mr. Howard testified yesterday that he had seen a cable from Mr. Hyde stating the date on which he was leaving New York in connection with the first visit of Mr. Hyde to the office of Minerals Separation Limited. Have you that cable message with you, and will you produce it.

A. I have, and I produce it.

The Commissioner notes that the cable message produced by the witness is dated February 5, 1910, and in a cypher which is translated as follow.. "Will sail on February 5th, intend to stop at Hotel St. Ermins. James Hyde."

3 Q. What is your memory as to the time relation between the making of the pencil drawing of which "Complainants' Exhibit First Tracing Slide Machine" is a tracing and the first appearance of Mr. Hyde at the office of Minerals Separation Limited?

A. It was at the latter end of January or a very early date of February Mr. T. J. Hoover himself prepared pencil drawings
513 in his room at our offices, after the invention had been disclosed to him by Messrs. Sulman & Picard.

4 Q. Was this before or after the first appearance of Mr. Hyde at the offices of Minerals Separation Limited?

A. Certainly before.

5 Q. In the cross-examination of Mr. Kindersley the fact appeared that Minerals Separation Limited has never paid a dividend to its shareholders. What have you to say as to this?

A. No dividend has been paid although substantial income has been earned. The policy of the Board always has been to use the funds for the general betterment of the Company's processes, also for introducing the use of the processes to mine owners and others in different parts of the world as well as to seek investments themselves by the way of acquiring raw material, that is to say, mines or dumps of tailings or ores suitable for use thereby, and also to defend the Company's patents from attack by third parties as well as to protect the Company's interests against infringement by third parties. For these reasons the funds of the Company have been nursed so as to leave it in a strong position financially to carry out the same.

6 Q. Have you had prepared, and will you produce a statement of expenditure incurred by Minerals Separation Limited in introducing the agitation-froth process?

A. I have, and I now produce it. It is self explanatory.

514 The statement produced by the witness is offered in evidence and marked "Complainants' Exhibit Statement of Expenditures in Agitation-Froth Process."

7 Q. Have you had prepared and will you produce a statement of expenditures by Minerals Separation American Syndicate, Limited, in the introduction of the agitation-froth process?

A. I have, and now produce it. The statement shows first that in the United States of America the Minerals Separation American Syndicate has spent the sum of £12,360.15.5, in Mexico £1,401.16.8, and with regard to Canada £1,433.9.7 or a total of £15,196.1.8. In this sum is included the monies paid to Mr. James Hyde by way of salary and expenses while he was in the Company's services. It will be noted that the statement was made up to the 31st of July, 1912.

The statement produced by the witness is offered in evidence and marked "Complainants' Exhibit Statement of Expenditures by American Syndicate in Agitation-Froth Process."

8 Q. I note that this statement says that it does not include any litigation expense or any of the costs in the present suit, but I would like to know whether or not, exclusive of litigation expenses and also as I understand patent expenses and all payments to the
515 American counsel, it represents the expenditure in the effort to introduce the agitation-froth process into use on the North American Continent?

A. Yes.

9 Q. Have you had prepared and will you produce a statement of the tonnage of tailings and slime treated by Minerals Separation agitation-froth process at Broken Hill, Australia, with concentrates produced as officially returned by the licensees of Minerals Separation, Limited?

A. I have, and now produce it. The statement will be self-explanatory.

10 Q. Have you had prepared and will you produce a statement including the proportionate profits of Minerals Separation, Limited, from joint ventures and royalties received from licensees in and for the use of the agitation-froth process?

A. I have, and now produce it. I think this statement will be self-explanatory.

The statement produced by the witness in answer to 9 Q. is offered in evidence and marked "Complainants' Exhibit Statement of Tonnage Treated by Agitation-froth Process at Broken Hill, Australia."

The statement produced by the witness in answer to 10 Q. is offered in evidence and marked "Complainants' Exhibit Statement of Profits and Royalties on Agitation-froth Process."

516 11 Q. Have you prepared and will you produce a table of tonnage of material treated, and concentrates obtained by Sulphide Corporation, Limited, with the agitation-froth process?

A. I have, and I now produce it. I think it will be self-explana-

tory. I may add that this table was carefully checked by the Sulphide Corporation in London.

The table produced by the witness, consisting of a large and small sheet, is offered in Evidence and marked "Complainants' Exhibit Table of Sulphide Corporation Operations with Agitation-froth Process."

12 Q. Mr. H. C. Hoover testified as a witness for the defendant and in answer to 24 X Q. said that his Company, to wit, the Zinc Corporation, Limited, had been practically bankrupted by the trial of the Minerals Separation process, referring to the operations of that process during the year 1907 for a period which he said was for some four or five months. What have you to say to this testimony?

A. I am very sorry to say it, but I must characterize Mr. Hoover's statement as absolutely ridiculous. So far as I know the test lasted from the beginning of April till the end of July or only four months. The power plant, grinding plant, housing and everything else had previously been erected and used for trials by, I think, two other processes. When these failed the Zinc Corporation even con-
517 verted the treatment plant used for the Potter and Queneau processes to adapt it for use for the Minerals Separation process. It is almost inconceivable to believe that the test could have cost them, or I should say legitimately cost them, more than from 10 to 15 thousand pounds, and against that, even, they would have recovered from ten to eleven shillings per ton of ore treated by the sale of the concentrates made, so that even accepting for argument's sake the higher figure of £15,000, it is absurd to say that the expenditure of that sum could have bankrupted them.

13 Q. Please briefly outline any knowledge that you had at or before the period of this four months' use of the Minerals Separation process as to the financial condition of the Zinc Corporation, Limited.

A. The Zinc Corporation were in financial straits so early as July, 1906, when Mr. H. C. Hoover submitted certain figures to me regarding the position with a view to getting our group to finance it. By reason of the liabilities which that corporation had incurred, and which amounted to a very large sum, no business resulted with us. In April, 1907, they were in financial straits again and during April had to raise a temporary loan of £50,000, in which Mr. Curle and myself took a participation of 5 per cent., amounting to £2,500, but as a matter of fact only £30,000 was called so that our financial participation amounted to £1,500.

14 Q. I call your attention to the deposition of the defend-
518 ant herein, Question 20 and answer thereto, appearing on pages 55 and 56 of the defendant's printed record. What have you to say as to the statements contained therein?

A. I extremely regret that Mr. T. J. Hoover's name should have been dragged into this case at all. The matter referred to relates to a difference between Mr. Hoover and my Company during January of 1911. That difference has been settled and, so far as my Company is concerned, and I personally, we consider that, and treat it,

as a closed episode. It is therefore with reluctance that I feel it my duty to contradict certain statements made by the defendant which are at variance with fact.

It is not true that Mr. Hoover took to his new office a case containing a file of papers which included the accumulation of his own correspondence and notes, etc.

The facts are these: Mr. Hoover terminated his agreement with the Company on the 31st of December, 1910, when all connection between him and the Company ceased. We parted on very friendly terms and a suggestion was made from our side, and assented to by him, that if possible he should continue in a consulting position to the Company, and he was asked to mention his terms and conditions later on, which he did, but as these terms were of such an exorbitant nature the Board reluctantly felt obliged to decline the consulting position with Mr. Hoover. On the 12th of January, 1911, it was discovered for the first time that when Mr. Hoover left the
519 Company's office he had taken with him some 240 to 250 files or dossiers from the engineering department, all of which belonged to the Company. These files or dossiers had been kept in one of the Company's own cabinets for the use of the engineering department. It may be quite true that Mr. Hoover also kept some of his own papers in this particular cabinet but the fact remains that when he left the Company's offices he had the whole of the 240 or 250 files of the Company's papers taken from the Company's cabinet and transferred into a similar cabinet of his own, which he had sent into the office at the last moment for that purpose. This removal of the documents took place without the knowledge of myself or any of the Board of Directors and certainly not with our consent.

When this fact was discovered on the 12th of January, 1911, a special meeting of the Board was immediately called and the matter was discussed with the Company's solicitors, as it had a very serious bearing because of the fact that the Company was then directly engaged in two law suits and also indirectly connected with the two law suits brought against the Sulphide Corporation, one of our licensees, so that the disappearance of these documents had a disconcerting effect. One of the directors, Mr. Francis Gibbs, immediately communicated with Mr. Hoover by telephone, but Mr. Hoover refused to discuss the matter. Under advice of the solicitors of the Company a letter was addressed to Mr. Hoover on the 13th of
520 January demanding the immediate return of these documents. This letter was delivered to him in person on that date by the Secretary of the Company but no return was made. On the following day an injunction was obtained to restrain him from parting with any of the documents but meanwhile on the morning of the 14th Mr. Hoover had taken his departure for abroad. After his return from abroad the documents were returned to the Company and we have considered it ever since as a settled matter. I can only say again that it is with great reluctance that I have had to go into details as far as I have done, but I consider it my duty for the information of the Court.

I would here also say, and most emphatically state, that if the pro-

ceedings in the Court at that time were published in the public press, and I believe they were, that such was done without the knowledge and without the consent of myself or any members of my board or any officer of my company, and that I personally knew absolutely nothing about such publication until my attention was drawn to it late on the afternoon of, I think, the 16th of January, and I personally sincerely regret that such publication ever took place.

15 Q. In the deposition of the defendant, in answer to Q. 4 on page 44 of defendant's record, appears a statement as to the reasons stated to the Board of Directors of your Company as to the declination of the defendant of the request that his contract should be made for two years, as follows:

521 "Further, that a year might indicate to us that it was not "wise to attempt to do business together further, and that "during the year I should come into possession of an inheritance "which, supplementing my own earnings and savings, would permit "me to operate independently upon a modest basis."

What have you to say to this statement?

A. I distinctly remember the defendant mentioning to me personally, and he may have done so in the presence of other members of the board, that he expected such an inheritance, but the reason why he did not wish to extend his agreement beyond one year was principally due to the fact that some high authority of the American Government Education Department had offered him some position on that Department, exactly what it was I do not remember, and that, if that position were given to him, he would prefer to accept such an appointment rather than to continue a mining practice, as educational work was more agreeable to him; but I certainly do not remember as one of the reasons given that the inheritance would permit him to operate independently in mining business. By mining I mean mining and metallurgical business.

16 Q. Mr. John Leechman has been mentioned at times in this testimony. Has he been in London at any time during the taking of this testimony, and where is he, if you know?

522 A. Mr. Leechman has not been in London since the 5th of August. I think he left for Sweden some time during the 3d week of July, and he has been there ever since.

Direct examination closed.

No cross-examination.

Deposition closed.

JOHN BALLOT.

By Mr. Williams: The following documents marked for identification during the progress of this Commission, and identified by the markings, are offered in evidence, each being entitled with its identification mark preceded by the words "Complainant's Exhibit":

Sulman & Picard Report March 3, 1905.

Higgins' Report March 2, 1905.

Higgins' Report March 16, 1905.
Sulman & Picard Report May 3, 1905.
Sulman & Picard Report March 4, 1904.
Sulman & Picard Report November 19, 1903.
Sulman & Picard Report March 25, 1903.
Sulman & Picard Report May 5, 1903.
Sulman & Picard Report September 24, 1903.
Sulman & Picard Report April 19, 1904.
Sulman & Picard Report May 2, 1904.
Sulman & Picard Report May 18, 1904.
Sulman & Picard Report February 17, 1905.
523 Sulman & Picard Report February 21, 1905.
Sulman & Picard Report February 24, 1910.
Minerals Separation Letter March 3, 1905.
Minerals Separation Letter March 6, 1905.
Nutter Report July 28, 1910.
Nutter Report December 3, 1910.
Assignment Froment to Ballot November 17, 1903.

The apparatus marked for identification "Sulman & Picard Slide Machine" is offered in evidence and marked "Complainants' Exhibit Sulman & Picard Slide Machine."

HUGH FITZALIS KIRKPATRICK PICARD, a witness produced on behalf of complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

1 Q. Are you the same Hugh Fitzalis Kirkpatrick Picard who has heretofore testified in this suit at the request of defendant's counsel, as a witness for the defendant?

A. I am.

2 Q. I now show you Complainants' Exhibit Sulman & Picard Slide Machine and ask you who made that apparatus?

A. I made that apparatus in my own private workshop at my house.

3 Q. When did you make it?

524 A. In the Autumn of 1909, probably in the month of November or December at the latest.

4 Q. Was this the first or the last of apparatus of this general character made by you?

A. This was the last apparatus of this kind, which satisfied me as being suitable for the purpose for which it was designed.

5 Q. Did you, prior thereto, make other apparatus of the same general type, and if so, generally when and how many?

A. I made prior to this machine three or four different machines which had the same object in view, that is the efficient cutting off of the froth from the gangue. This particular machine was first built by me with wrought metal sliding plates which, however, were not

perfectly flat, but as the machine showed that it would work satisfactorily, I had cast plates made for the sliding parts and these plates were adapted to this particular machine. The plates were made by Messrs. Cathcart and Company in, I think, December, 1909.

6 Q. When you completed the apparatus, what did you do with it?

A. We made several tests in our laboratory with it and, after proving that it worked to our satisfaction, we asked Mr. Ballot to come and see it. He did so and then sent Mr. T. J. Hoover to inspect it. This would probably be in January, 1910. After Mr. Hoover had seen it I went to his office and gave him my original drawing from which this machine was built. Mr. Hoover said that he would use this as a basis for a standard machine for use in Minerals Separation Company's tests.

525–27

Direct examination closed.

Cross-examination.

By Mr. Scott:

7 X Q. Did not Mr. Hoover at some time considerably prior to the Autumn of 1909 explain to you the idea of the Shear Gabbett or slide machine and show you sketches of the same made by him?

A. No. I never had any communication with Mr. Hoover as to the design of a suitable laboratory testing machine, and the type evolved, as shown by this exhibit, was entirely the work of Mr. Sulman and myself without any suggestion of any kind from any one else.

No cross-examination.

Deposition closed.

HUGH F. K. PICARD.

528 COMPLAINANTS' RECORD.

Volume II.

529 United States District Court, District of Montana.

In Equity.

MINERALS SEPARATION, LIMITED, and MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, Complainants,

vs.

JAMES M. HYDE, Defendant.

Depositions of witnesses in rebuttal in behalf of complainants in the above-entitled suit, taken by agreement of counsel before Bernard Cowen, Esq., a Notary Public in and for the County of New York and State of New York, acting by consent of counsel for both

parties as Special Examiner under the 67th Rule in Equity as amended, at the office of Henry D. Williams, 76 William Street, Borough of Manhattan, County of New York, in the City of New York and State of New York, beginning on Monday, October 14, 1912, at eleven o'clock in the forenoon.

Appearances:

Henry D. Williams, Esq., for Complainants.
Walter A. Scott, Esq., for Defendant.

ADOLF LIEBMANN, a witness, produced in behalf of complainants, having been duly cautioned and sworn, testifies as follows:

530 Direct examination.

By Mr. Williams:

1 Q. Please state your name, residence, age and occupation.

A. My name is Adolf Liebmann; my residence, Weybridge, near London; age, sixty; am a consulting chemist.

2 Q. Please state your education and other qualifications to testify as an expert as to the subject matter in controversy in this suit.

A. I am a Doctor of Philosophy and Master of Arts of the University of Bonn, Germany. I studied mineralogy under Prof. Vom Rath. I studied physics under Prof. Clausius, the famous scientist, who evolved the mechanical theory of heat. I studied chemistry under Prof. Kekule, who is considered by many to have been the most eminent chemist of the last century. I was for five years assistant to Prof. Kekule. I am a member of a number of learned societies; of the German Chemical Society, of the German Society of Applied Chemistry. I am a member of the Society of Chemical Industry, the corresponding English Society. I am a member of the Royal Institution of England, etc. I am a Past Lecturer of the School of Technology of Manchester. I am a member of an advisory committee to the Council of the University of Leeds. Since 1884, that is for twenty-eight years, I have been consulted with regard to chemical and physical problems, and I have frequently since
that time been called as a witness to testify before the Courts
531 in matters relating both to chemistry and physics, in England, Germany and the United States. I am retained by a number of the very largest manufacturing concerns in Germany, England and Canada in matters referring to chemistry and to physics. Ever since 1881 I have been engaged in the solution of technical problems both practically and theoretically.

3 Q. Have you studied the patent in suit No. 835,120 to Sulman, Picard and Ballot, issued November 6, 1906, for an improvement in ore concentration, and do you understand it;

A. I have read this specification and I fully understand it.

4 Q. Have you studied the various patents introduced in evidence by the defendant, as well as the testimony of the defendant, James M. Hyde, and of defendant's expert, Dr. Eugene A. Byrnes?

A. I have devoted about three months to the study of the patents mentioned in the suit and to the issues raised by them. I have read the testimony of Dr. Byrnes and of the defendant.

5 Q. Having in mind the state of the prior art as disclosed by the several patents referred to in defendant's testimony, please give consideration to the invention shown, described and claimed in the patent in suit, and give such explanation thereof as will assist the Court in its understanding of that invention.

A. Having carefully considered the objections raised by the defendant and disclosed in the different patent documents,
532 which I may say represent practically the whole history of this branch of ore concentration, I have formed the opinion that the invention now in controversy is an entirely novel, ingenious and unexpected process, which by its great simplicity fulfils the most ideal demands of ore concentration.

All former efforts which have been made to make use of oil in ore concentration consisted in making use of the attraction of oils for minerals and in separating them either by producing a buoyant mixture of oil and minerals which being lighter than water was capable of floating on water, or in kneading the fine particles of minerals together by oil in such manner that they form larger aggregates of minerals in oil which would settle in consequence of their heavy weight below the gangue and could be easily separated from it. Later attempts have been made to lift such aggregates, by the generation of gases or by blowing air through perforated pipes into the mass formed by the previous process, to the surface of the solution of the water and to collect the minerals in this way. In all these attempts the character of the minerals was lost. It was the character of the oil which predominated and completely buried the well defined properties of minerals. In other words, it was a mixture of minerals with oil, either in large quantities or in smaller quantities, which was produced by employing the mineral in oil.

The present invention differs essentially from all previous
533 attempts. It is true that oil is one of the substances used, but it is used in such quantities which were never heard of, and it produces a result which was never obtained before. The result is that the minerals are obtained as a froth of very peculiar character. It is a froth consisting of air bubbles, which in their covering film have the minerals embedded in such manner that they form a complete surface all over the air bubbles. The remarkable fact with regard to this froth is that, although the very light and easily destructible air bubbles are covered with a heavy mineral, yet the froth is stable and utterly different as far as this property is concerned from any froth known to me. It appears as if the minerals were protecting the tender air bubble like an armor, and, instead of destroying it, were actually guarding it. The froth has a long life. One feels tempted to say it is permanent, at least as far as metallurgical operations are concerned. I have myself seen a froth standing for twenty-four hours without the least change having taken place. Further, a very striking difference between the previous processes and the process of the patent in suit is the difference between failure and success. This I will explain more fully hereafter.

The simplicity of the operation as compared with the prior attempts is startling. The whole work which has to be done is to add an infinitesimal quantity of oil to the pulp, to which one may or may not add an acid, agitate from two and a half to ten
534 minutes, and collect the froth which appears after a few seconds collecting on the surface. The froth contains a large percentage of the minerals present in the ore. For continuous work nothing is required but an agitator, which is connected with another vessel, such as a spitzkasten, from which the concentrates overflow as a thick froth.

The appearance of this froth is most remarkable. The color and lustre of the minerals is the same as if no oil were present. It is very strong and, even if the top layer is destroyed, the underneath layers will bear it without being destroyed themselves and carry the mineral fallen from the top layer along. No air bubbles are visible,—nothing but the uninterrupted covering formed by the concentrates.

I should like to add that I shall make a more detailed description of the invention and differentiation from prior processes when the patent in controversy and the specifications offered as objections and anticipations are discussed.

6 Q. Please now give such explanation as may assist the Court in the understanding of the patent to Bradford, No. 345,951, issued July 20, 1886.

A. As I understand Bradford's invention, it is a process for collecting losses occurring on Rittinger tables, Frue vanners, and jigs. It depends on the well known phenomenon of skin flotation. For the purpose of this invention no oil is used and no agitation in the true sense of the word. The invention is illustrated by a set of drawings which represent the old and well known apparatus
535 mentioned before, with the additional plant proposed by the inventor to carry out his invention. In these processes usually losses occur, due to the phenomenon mentioned above. The inventor provides a plant to prevent such losses. Figure 1 shows a Rittinger table, Figure 2 shows a Frue vanner, and Figure 4 a jig. In Figure 1 the Rittinger table is connected by a plate *a*, which rests on the surface on a spitzkasten marked *c* in such manner that the material leaving the plate *a* will be on the surface of the water. The tailings will sink down to the bottom of D. The minerals will pass over the wall *i* into a second spitzkasten filled with water but of shorter height than the first one, so that the mineral has to fall a distance before it touches the water. In this way the mineral sinks and is collected at the bottom of the spitzkasten. The second figure illustrates a Frue vanner. P represents an endless belt. In the drawing, which is a diagrammatic sketch, of course, the side elevations, which are always present and essential, are not shown. The belt inclines; traveling from the lower inclination to the higher inclination. The sand and water, which always carry some minerals, flow downward, while the minerals are carried by the belt in the opposite direction. Bradford proposes to save the losses which are

due to the presence of the minerals in the sand and does it by collecting the tailings which carry the minerals previously lost on a Frue vanner, over a belt in which they are exposed to the air.
536 They are then taken up by a kind of dredger, emptied from there into a trough or incline *b*, from which they are delivered on a belt E, a portion of which is immersed in water. The upward movement of this belt allows again aeration of the tailings. When they are delivered to a similar apparatus to that described in the other processes the sands will fall down into the water, while the minerals are carried by skin flotation into a second receptacle in which they are collected. The collecting apparatus both for tailings and for minerals is duplicated and minerals and tailings are obtained on both sides of the belt. Figure 3 is a sketch of the plan suggested by the inventor to save minerals from waste water which has but little fall. The principle used is the same as illustrated in the previous sketch. Figure 4 is a type of a jig. This apparatus is used for the separation of coarse minerals and sands. By moving the piston up and down, the minerals and sands arrange themselves according to their specific gravity or, more correctly, according to their falling power in water, the minerals being below and the sands on top. But some minerals usually rise to the water surface and these the inventor proposes to collect by the same device as described in the other apparatus.

To recapitulate: Bradford's invention is not an oil process. No slimes can be treated by it. The phenomenon used depends on skin flotation.

I cannot conceive of any other reason why this patent has been mentioned by defendant, but for completing a historical
537 sketch of the many attempts which have been made during a large number of years to solve the problem which has given so much trouble to mine owners and which has caused such great loss of material. Dr. Byrnes in his direct testimony only explains Bradford's invention without showing any connection of this process with the patent in suit, and in his cross-examination he says that in general the phenomena of skin flotation and the agitation froth may be attributed to the same cause, but specifically not. I take this to mean in both cases the minerals are made to float, but that the reason and the cause of such flotation are essentially different and that, therefore, the two processes must be different. If I am correct in this reading, I am in agreement with Dr. Byrnes. If not, then I will add that the Bradford process depends on surface tension, while the agitation froth of the patent in suit depends on the fact that the froth produced is lighter than water, and follows the natural law that bodies lighter than water will float on the surface.

7 Q. Please now give such explanation as may assist the Court in the understanding of the patent to Carrie J. Everson, No. 348,157, issued August 24, 1886.

A. Carrie Everson's process is a process for the concentration of ores by means of oil and acid, but the inventor believes that its commercial value is probably restricted to ores bearing precious metals, such as gold, silver and copper. But even this limited fore-

538 cast proved to be too sanguine, as it has never come into practical operation. She has devised two ways of carrying her process out. One way is described on page 2, line 1, and finishes up on page 2, line 74. She describes as an example a laboratory experiment. She prepares first, at a temperature below 120° Fahrenheit, a compound of cotton-seed oil and sulphuric acid in proportion of sixty of the former to eight of the latter. The mixture is allowed to stand for some time and then water is added to it gradually, and the mixture is stirred after each addition of water until it stiffens. When all the water has been added, the compound thus obtained is added to the ore and the ore is thoroughly incorporated with the compound. After this has been done, water will be applied to the mass whilst it is being broken up in sufficient quantities to remove the sand or quartz from the ore. The washing again has to be done very thoroughly to accomplish the result of the invention. I have carried this out in experiment, in order to see the working of this process, and I have come to the conclusion that it is an utterly impossible process for the treatment of large quantities. The proportions used are about 6.2 cc. of oil to 112 grams of water. The propor- of the incorporation of the ore with the oil and acid is a kind of a pudding. There is no similarity of this process or of its result with the agitation froth of the patent in suit. I notice in Dr. Byrnes' evidence that he is silent about this part of Everson's patent,
539 and he apparently has come to the same conclusion that I have, namely, that this part of Everson's invention has nothing to do with the process of the patent in suit and that it is an impossible process.

The second mode described consists in mixing the ore with the oil and in cutting the gangue out after such mixing by addition of acidulated water. The proportions between ore and oil are of about 100 of ore to 20 of oil, and the principle which guides the inventor and on which the invention is based is that the sand must be heavier than the mixture of mineral and oil. After the oil has been incorporated with the ore, the acidulated water is added and the mass is thoroughly agitated and the concentrates are washed out by a constant overflow of water. I have carried this out in experiment by incorporating 63 cc. of Texas fuel oil with 300 grams of Broken Hill ore, adding the paste thus produced to 2,000 cc. of water containing .75% of sulphuric acid. The whole mixture was contained in an apparatus which has been called in these proceedings the Slide machine. The mixture was thoroughly agitated for six minutes and the agitation then stopped. Oil containing minerals and some air bubbles were both at the top and at the bottom of the water. The mixture was then slowly agitated and allowed to flow into a spitzkasten, into which at the same time a gentle up-current of acidulated water was maintained. The oily liquid flowing on the surface which contained some of the minerals was collected by over-
540 flow. The tailings which sank to the bottom showed, on examination, considerable quantities of minerals and oils. This process of Everson depends on the fact that a mixture of oils with minerals, if this mixture is lighter than the gangue, can be

removed by overflow by means of an up-cast of water and separated from the gangue. It is from the results of my experiments an unsatisfactory process, and my opinion of it is confirmed by the fact that the process has never been carried out in practice.

I am strongly of opinion that there is nothing in either of these processes which has any resemblance to the phenomenon first discovered and described in the patent in suit. Everson's processes both deal with oil in quantities which would properly be called microscopic quantities. The ore to be treated must be free from gangue slimes consisting of clay. The result of the two Everson processes is unsatisfactory. The cost involved is large. The patent in suit uses microscopic quantities of oil which cannot be discovered in the final result unless by chemical analysis and examination. The result is, as I have mentioned so often before, an absolutely new phenomenon, of which I could not find anywhere in literature an analogue. According to my knowledge, it is the first time that a froth is described which behaves like a bubble of air enclosed by a sheet of metal. It actually has the properties of an air bubble enclosed in such a manner.

I have read that part of the testimony of Mr. Hyde which
541 refers to the Everson patent, and I disagree with the statement that Everson broadly disclosed the preferential oiling of mineral particles by oils and fats, and I disagree with the same conclusion arrived at by Dr. Byrnes on page 121 of Defendant's Record, marked (1). The preferential affinity of oil for minerals was first discovered in modern times, according to my knowledge, in British patent No. 488 of 1860, to Haynes. I confess my ignorance of the passage from Herodotus which has been referred to in this testimony, until I read the testimony in this suit. It is very evident that the preferential oiling of metallic particles in ores by oils and fats was disclosed long before the Everson patent.

As to paragraph (2) in Dr. Byrnes' summary of the Everson patent, that is a correct statement of a novel disclosure of the patent, namely, that acid emphasizes the quality of the gangue to resist being coated with oil.

As to paragraph (3) in Dr. Byrnes' summary of the Everson patent, I notice that she advises the use of tallow in melted condition. Although I have not discovered any of the instructions which Dr. Byrnes describes as being contained in the Everson patent, I think it is fair to assume that she could only use liquid substances. I am, however, of opinion that although she includes, for instance, tallow within the scope of her invention, she prefers to use liquid bodies and she advises their use, as the examples given by her are
542 carried out with oily substances capable of being used at ordinary temperatures, and as it is obvious that she has given the best method known to her at the date of the patent.

Adjourned to Tuesday, October 15, 1912, at 10:30 in the forenoon, at the same place.

New York, October 15, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

(Answer to 7 Q. continued:) On a fair reading of the patent to Everson, No. 348,157, it seems fair to say that she did not include heating of the mixtures. It is true she says tallow is to be used melted, but that can only refer to the first process, in which the temperature of 120° Fahrenheit is stated to result from the mixing of the tallow with the sulphuric acid, or to the use of a mixture of two oil substances such as is mentioned on page 2, lines 72-73, i. e., a combination of petroleum with tallow (heated). It is further true that the inventor mentions on page 3, that it is not essential to this invention that the vegetable oils should be first mixed with acid, but that they can be used in both processes described by the inventor. It is clear, however, from this paragraph that she has not made tests with all oils. Tallow is not a vegetable oil and, therefore,
543 the only reference to it and of its use is contained in the preparation of the mixed compound before mentioned. It is not an important point, but the true readings of Everson's specification does, in my view, not disclose the application of heat.

I agree with paragraph (4) of Dr. Byrnes if the addition is made: but the result must be that the mixture of minerals and oil is of less specific gravity, i. e., of less falling power in water, than the gangue. That is the fundamental condition on which the process depends.

I agree with (5), and also state that not only the quartz ore, but also the minerals contained therein, are reduced to a powder.

As to paragraph (6), the statement ending with "preferentially oiled" can only refer to the first process mentioned, in which the acid is present in the oil. In the second process, in which the oil is mixed with the ore, the agitation of the oiled ore with acidulated water is for the purpose of cutting the gangue out.

As to paragraph (7), Everson's instructions are to treat the concentrated mass prepared by the aid of petroleum or of a liquid constituent thereof by means of a constant overflow, i. e., by a method somewhat different from the method to be used when a vegetable or an animal oil or a fatty constituent thereof is used. The concentrates plus oils obtained by aid of the latter compounds are apparently to be treated in the way as described in the first process, namely, by opening and breaking up the mass and thoroughly stirring
544 it in water.

On page 163 of Defendant's Record, Dr. Byrnes describes an experiment which is meant for an illustration of Everson's invention as revealed by the second process. The description of the mixture of oil and ore as having the consistency of damp sand is not very fortunate. The mixture of the oil and sand forms a pasty mass, according to my experience. The experiment was carried out in a Slide machine at a temperature of 27° C. (80 3/5° F.). There is

no instruction whatever in Everson's patent that such a temperature should be used. I consider it unfair to the patentee to introduce any variations when testing the process of a patent. Dr. Byrnes then continues to say that after agitation he obtained a good froth. I deny that in carrying out Everson's invention as described, a good froth is obtainable. It is a magma consisting of oil, some water, minerals and gangue. He then removes the alleged froth, but does not say how; it is, however, quite clear not by the method suggested and specified by Everson. Then he repeats his process of agitation and collection of so-called froth nine times. There is no description of such a process to be found in the patent. Everson's invention depends on the fact that the mineral and oil must be lighter than the gangue. After the removal of the first mixture of concentrates and oil, which, of course, is bound to effect the removal of the largest amount of oil present, the condition of the remaining minerals was surely
545 different from that condition which forms the basis of Everson's invention. Dr. Byrnes' condition of mind when carrying out this experiment is quite comprehensible. It is frequently found and it originates from the fact that a man cannot put himself back to the time when a certain invention was made. Dr. Byrnes treated Everson's patent not as having been made in 1885, but in 1912. By repeating the agitation nine times, removing after each agitation the oil and what it may have contained, he may finally have come to conditions in which very little oil was mixed with the minerals. The result of this experiment was a collection of concentrates weighing 144 grams. As no assay of this concentrate was produced the figure will tell us nothing. I have made an experiment to carry out Everson's invention as I understand it. I mixed 450 grams of defendant's ore, which, of course, was finely crushed, thoroughly with 90 cc. of crude petroleum, and the pasty mixture thus produced was agitated with 1600 cc. of water acidulated with 3 cc. of sulphuric acid. After thorough agitation, the mixture was run into a washing out vessel and the concentrate removed by a constant overflow of water. The tailings were allowed to run away from the bottom. The concentrate was dried and the oil removed in the usual way by washing with petroleum ether. It weighed 256 grams. An assay showed it to contain 12.1% of zinc, and the contents contained in the concentrate were, therefore, 31 grams.

546 In summing up Everson's invention, I say that it contains an important discovery, namely, the utility of acid in removing the gangue from the oil. It reveals the first attempt, which, although unsuccessful, is still of great historical interest, of trying to solve the problem of ore concentration by a combination of oils and acid. It took twenty years more before it was finally solved and an enormous amount of intermediate work, which, although perhaps in some instances an advance on Everson, yet was still far away from the final solution of the problem.

8 Q. Please now give consideration to the article published in the Daily Herald Democrat of Leadville, Colorado, on Wednesday, October 30, 1889, entitled "An Important Invention," the same being

in evidence herein as "Complainants' Exhibit, Fryer Hill Publication."

A. The extract from the Daily Herald Democrat of October 30th, 1889, refers to a new method of treating dry silicious ores and an experiment of the concentration of such a dry silicious ore containing silver is described therein. There are several facts which induce me to believe that this extract refers to an experiment according to the previously discussed Everson invention, to which some new developments had been added. The extract states that the new method referred — and was suitable for the treatment of silicious ore. A similar statement is contained in Everson's specification. It is further
547 stated that the ore treated was an ore containing silver and a concentration of the silver particles was obtained. Everson states that her process will probably only be valuable for the treatment of ores containing precious metals, such as gold, silver and copper. According to the report, the ore is, after being crushed and while dry, mixed with oil, which again is in accordance with the Everson process disclosed in 348,157. The quantity of oil to procure thorough mixing of ore and oil must be somewhat similar to the quantity specified by Everson. The apparatus is new and apparently also the mode of agitation which is described. It is a specific agitator which is used, namely, arastra-like fans, which I believe produce a slower agitation. Another development is the use of heat. There are some other details in the construction of the plant which do not call for comment. The dividing of the oily layer from the water is assisted by heat. With the exception of the use of heat, no new element has been disclosed in this extract, which was not revealed in the concentration process of the Everson patent. It is not as clear a description as the Everson patent and conveys much less information than the patent. I conclude by saying that no possible information is contained in this document which could lead anybody anywhere near the invention of the patent in suit, and that it is quite impossible according to this description to produce by agitation any true froth and much less the agitation froth of the patent in suit.

548 9 Q. Please now give consideration to the article published in The Engineering & Mining Journal of November 15, 1890, entitled "Baker City, November 10," and in evidence herein as "Complainants' Exhibit, Criley-Everson Publication."

A. The experiment therein described seems to me again the process of the Everson patent, with slight modifications. The ore is crushed and thoroughly mixed with black thick oil. It will be remembered that in the patent of Everson the use of petroleum is described in the example No. 2, and the same in the article published in the Daily Herald Democrat. In the article contained in The Engineering & Mining Journal, black thick oil is described as having been used. To make a proper mixing with black thick oil, a rather larger quantity must be used than would be necessary if petroleum was used. The water slightly acidulated with sulphuric acid is heated nearly to boiling, and then mixed with the mass of oil and ore. In the patent of Everson no heat is mentioned at all. In the earlier description of an experiment published by the Daily Herald

Democrat, the ore and oil is apparently mixed with petroleum and is then heated with steam. In the present case, the oil and ore mixture is mixed at once with nearly boiling water. The description then goes on, "a thick scum of sulphurets rose to the surface and was skimmed off." That can only mean that a layer of oil containing minerals appeared on the top of the water, and the "hitherto black ore" 549 left behind, the description continues, was white as snow, in fact, pure silica.

The description is very scant and practically no details are given. It would be impossible to draw from it any other conclusion but that it was a performance of the Everson patent process with some slight modifications, a recovery of minerals from an ore by oil flotation. If this paragraph has been put on record with the intention of disclosing the agitation froth phenomenon and the process leading thereto, then I say that it does not disclose anything of the kind, and that it does not even get us any farther than the Everson patent, with the exception that it contains a description of the use of hot water. Otherwise there are no details whatever and the experiment strikes me as a description of a laboratory test.

10 Q. Please now give consideration to the patent to Hebron & Everson, No. 471,174, issued March 22, 1892, for Process of Concentrating Ores.

A. This invention is based on microscopic study of a finely powdered ore whereof the rock matrix is crystalline, and on a discovery which the inventors believe to have made, namely, that, contrary to public belief and information, the rock particles are of greater specific gravity than the metallic and mineral particles. The results of the microscopic examination show that mineral particles have a porous and irregular form and structure, whilst the rock particles have a smooth and glassy surface. These are the results which the 550 patentees have discovered by their research. The treatment proposed by the inventors is only suitable for ore free from amorphous gangue slimes, and it consists of forcing buoyant material into the pores of the minerals or making such materials adhere to the irregular surface of the minerals in such quantities that the natural tendency of such particles to remain suspended in fluid is so much increased that they will float on the surface for sufficient time to be separated from the gangue. A number of substances are described as suitable for the purpose of the invention—charcoal, lampblack, bark, moss, cotton, wool, sulphur, aluminum hydrate, sodium oleate, metallic sulphates, etc., and it is stated that the salts must not only be dry in the ordinary sense, but entirely dehydrated, so as to render them amorphous. The carbonaceous substances (charcoal, lampblack, etc.), are specially recommended for the reason of their cheapness, of their positiveness of action, and of their destructibility in the furnace. It is essential for the purpose of the invention that no substance should be used capable of being removed by the fluid to which the ore is finally delivered for the recovery of the minerals. The quantities to be used are rather peculiarly expressed. The quantity of buoyant material should be equal in bulk to the bulk of the mineral contained in the ore. In practising this invention, the prop-

erly prepared buoyant material is equally distributed by mechanical devices with the ore particles, and the mixture so obtained is then submitted to a rubbing movement and pressure, for which
551 operation ordinary mill burrs are recommended by the inventors as effective. It is a necessary condition for the success of the operation that, when using carbonaceous substances, they as well as the disintegrated ores must be dry before the two are mixed, and then exposed to pressure. Chemically prepared buoy stock may be dissolved in water and thus mixed with the ore, but before being exposed to pressure and rubbing the mixture must be thoroughly dried. The use of oils is discarded. The invention discloses an attempt to reduce the specific gravity of the minerals by attaching to them substances of much lower specific gravity. In other words, an attempt to reduce the falling power in water of minerals by the adhesion of dry powdery substances which are lighter in specific weight. It has nothing to do with the invention of the patent in suit.

11 Q. Please now give consideration to the patent to Hebron, No. 474,829, issued May 17, 1892, for a Process of Concentrating Ores, this patent not having been heretofore referred to herein, and a copy of which I now hand to you.

A. The process described in this patent is stated to be an improvement on the process heretofore invented by Everson and Hebron, and described in the specification of patent No. 471,174, this patent being identified by the serial number of its application No. 404,400, and it purposes to effect the concentration of a certain kind of ore
552 heretofore found particularly impracticable and practically impossible to separate. It is not stated to which class of ores the inventor specifically refers, but it is fair to assume that it is for the same class of ore which is described in the parent specification referred to in this patent. The improvements consist—and they are the subject of the present invention—in obtaining a greater buoyancy in the joint mineral and metal particles and buoy st[illegible] than has heretofore been obtained. This object is achieved by [illegible]pelling from the minerals an appreciable quantity of the air and ot[illegible]er gases contained in the pores, cells, cavities and depressions, either by heat or vacuum, and in submitting the particles of the ore whilst so heated, together with the buoyant material, to pressure. In this manner, a two-fold work is done: the air is expelled and the holes or pores present in the materials are enlarged. The heating must not be so high that it might involve material volatilization of the values. The object of this invention is to unite as large a quantity of buoyant stock with the minerals as possible.

The invention is not an oil process for the concentration of ores. The use of oil is an impossibility. It is an attempt to increase the buoyancy of the result of the earlier patent by putting more buoyant material into the mineral than could be done by the process of patent No. 471,174.

The reading of the Everson patent No. 348,157, of the Hebron & Everson patent No. 471,174, and of the patent granted to
553 Hebron, No. 474,829, is highly interesting. The first invention was made in 1885. It was a process depending on oil

and in which oil was used in large quantities. Two attempts, at least, were made to introduce the invention into practice, one in 1889, and the other in 1890. Both apparently failed, and rightly so, because the process as revealed in Everson's specification could never be a practical process. It might have been a germ, if properly further developed, which might have led to the Elmore process, or even to the Cattermole process, but Everson being an inventor, and therefore imaginative, discarded oil and turned her versatile mind to other bodies, dry substances, for the production of buoyancy in the minerals. Thus she arrived, in collaboration with Hebron, at the invention which is disclosed in patent No. 471,174. The oil is discarded and specifically light materials, which must be applied dry or which must be dry after being incorporated with the materials, are proposed for buoying the latter. Then we have the Hebron patent, which was granted to Carrie J. Everson as one of the assignees, and which is stated to be an improvement upon the invention of patent No. 471,174, in which the property of the minerals of being capable of uniting with dry buoyant materials is enlarged as much as possible by removing the air from the pores and cavities and by enlarging the pores and cavities by great heat, so great that care must be taken that no material volatilization of the values takes place. The study of this series in their sequence makes quite tragic and pathetic
554 reading. It shows an inventive mind originating a new idea, the use of acid in the concentration of ores with oil. It shows the struggles of the inventor to induce the public to accept an unsuccessful, and therefore useless, process. It shows that she recognized the uselessness of her oil process, but that this failure does not discourage her; her inventive mind turns into other roadways, abandoning apparently as impossible the earlier direction. It is clear to anyone who is not biased, from the history told by these documents, that she did not, with all her efforts, invent or discover a successful oil process of ore concentration; that she was even very distant from Cattermole's invention, and that to allege that her unsuccessful process was in anticipation of the process of the patent in suit, the agitation froth process, is utterly absurd.

Adjourned to Wednesday, October 16, 1912, at 10:30 in the forenoon, at the same place.

New York, October 16, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

12 Q. Please now give consideration to the patent to Hockley, No. 466,753, issued January 5, 1892, for an Ore Slimer.
555 A. I understand this patent to be only an invention of apparatus designed to save the float mineral, usually called slimes, and sometimes termed flour gold and silver, and I agree with the view expressed by Dr. Byrnes on page 203 of Defendant's Record that the Hockley patent is

"a disclosure of the well-known fact that finely-divided gold and silver will float on water, illustrating the principle of surface tension flotation."

As to the opinion expressed on page 124 of Defendant's Record by Dr. Byrnes, my view of the process of this patent is as follows:

The falling power of a mineral when immersed in water is considerably reduced if the mineral is in a slimy condition. By the introduction of an up-current the mineral is carried to the surface of the liquid and if exposed to air, then the phenomenon of surface tension will come into play and prevent the minerals from sinking down.

13 Q. Please now give consideration to the patent to Rouse, No. 469,599, issued February 23, 1892, for a Method of and Apparatus for Separating Slime or Fines from Water Used in Milling Ore.

A. The invention described in this patent is for the same purpose as the previous one. It is not a process in which oil or acid is used, and the only agitation which I find therein mentioned is an agitation created by the introduction of air through a perforated pipe,
556 of which there are a number. The air bubbles carry in their way upward the slime alone and bring it to the surface. The foam which is mentioned in the patent (if there is any at all) is ordinary every-day-life froth which collapses one might say as soon as it is produced. I agree with the statement of Dr. Byrnes contained on page 203 of Defendant's Record that

"The Rouse patent, while describing a method of floating mineral as a froth by aeration, does not specify the use of acid,"

with the qualification that the process does also not disclose the use of oil, and that it is intended only for the saving of slimes from water used in milling of ore, containing the mill tailings.

14 Q. Please now give consideration to the patent to Francis Elmore, No. 676,679, issued June 18, 1901, for a Process of Separating Metallic from Rocky Constituents of Ores.

A. This invention relates to a method of separating minerals from the gangue by an oil flotation process. It depends on the fact that by immersing the ore in oil, only the minerals are taken up by the oil if water be present, and the gangue remains behind. That is the broad principle. It is, however, quite evident from the description that the separation is not a sharp one and that the gangue, after the first treatment with oil, contains still considerable quantities of the values and that new additions of oil to the tailings remaining
557 after the first treatment have to be made and the extraction repeated. The process depends on flotation by specific gravity. The pulp, which ought to be a freely flowing mixture, has a quantity of oil added and has to be agitated by slowly revolving agitation in such manner that the oil does not break into small globules. The minerals will be enclosed by the oil and the oil will float by buoyancy. This process depends on the well-known fact that you can reduce the specific gravity of a heavy substance by mixing with a light one. I may remark here that it is a process not suitable for the treatment

of slimes. The patent recommends the use of thick oil. I have made several experiments with regard to this patent and I find it correct that the principle of this invention is flotation by specific gravity. I need scarcely add that the process of this patent differs absolutely from the process of complainants' patent in suit, that it depends on utterly different physical laws, and that, as regards its economy and utility, the Elmore process and the process of the patent in suit cannot be compared with each other. The Elmore process is expensive and complainants' process, as far as I know, is the cheapest in existence.

15 Q. Please now give consideration to the patent to Alexander S. Elmore, No. 689,070, issued December 17, 1901, for Separating Mineral Substances by the Selective Action of Oil.

A. The discovery which is contained in this patent is that in some cases a slight acidulation enhances the selective action
558 of oil in a mixture consisting of an ore pulp and oil, from which the mineral is to be separated by oil flotation. The process is a development of the process discussed before and described in patent No. 676,679. The development consists in making use of Everson's discovery, that the presence of acid prevents oiling of the gangue. The patentee mentions as suitable acids oleic acid and sulphuric acid, and states that the quantity to be used need not exceed often one-five-hundredths part of the volume of oil or water employed in the operation. The remarks made about the patent mentioned before, No. 676,679, apply equally here.

16 Q. Please now give consideration to the patent No. 735,071, issued August 4, 1903, to Delprat, for Extraction of Zinc, Lead, and Silver Sulphides from Their Ores.

A. This patent depends for the separation of the mineral on the possibility of a gas which is generated in the mixture of a sulphide ore with water by an acid, attaching itself to the mineral and lifting the mineral to the surface whilst the particles of the gangue fall to the bottom of the fluid. The inventor says that in order to facilitate the process suitable salts are added to the solution to increase its specific gravity. The acid used and claimed is nitric acid, and the salts recommended to be added to the solution are nitrates, and the specific gravity of the solution should be 1.4. The inventor states that the gas is produced by the action of nitric acid on
559 the sulphide. To produce a gas in this way is chemically impossible. But, however that is, the process as described has no resemblance whatever with the process of the patent in suit. It does not depend on the presence of any oil. It does not depend on agitation. (As a matter of fact, it is clear from the drawing of the apparatus that there is no agitation whatever, that the mass cannot be agitated.) It is simply the lifting of a particle or of particles of mineral by a gas bubble. If a gas bubble should burst on its journey to the surface, the mineral would fall down again, and if a gas bubble should burst while on the surface, the minerals would likewise fall to the bottom. There is no mention of the formation of any froth in the patent and neither the process nor the result de-

scribed therein has any resemblance whatever to the process and the result of the patent in suit.

17 Q. Please now give consideration to the second patent to Delprat, No. 768,035, issued August 23, 1904, for Extracting Zinc or other Sulphides from their Ores, this patent having been put in evidence by the defendant, although not referred to by any of defendant's witnesses.

A. The process is the same as of the first patent to Delprat, with one exception. Instead of using nitrate and nitric acid, the patentee uses sodium sulphate and sulphuric acid.

I should add as to both these Delprat patents that no oil whatsoever is used and that heat is relied upon, in the second patent
560 the heat being just below boiling point.

18 Q. Please now give consideration to the patent to Potter, No. 776,145, issued November 29, 1904, for Process of Separating Metals from Sulphide Ores.

A. This patent describes a process which belongs to the same class of processes described in the Delprat specifications, namely, the lifting up of minerals from ore pulp by means of gas bubbles generated in the pulp mixture. The agent used for the generation of gas bubbles is sulphuric acid in quantities that the water present in the pulp contains from 1 to 10 per cent. of sulphuric acid. The quantity which will usually be sufficient is 2½ per cent. of sulphuric acid contained in the pulp solution. Heat has to be used in Potter's process, also agitation, but it is clear from the drawing, and equally so from my experimental experience, that the agitation must be very slow and that brisk agitation will defeat the objects which the inventor contemplates to achieve, and the "pasty mass" (page 1, line 43), would by brisk agitation be sent to the bottom. I notice a statement in claim 3 that the separation of the minerals from the ore is due to bubbles of sulphuretted hydrogen formed by the action of the acid on sulphides. Although a smell of sulphuretted hydrogen can be observed during the performance of this process as well as of the second process of Delprat, the lifting power is due, in my view, to carbonic acid, generally. There are in most ores carbonates present and the action of sulphuric acid on carbonates at
561 Potter's or Delprat's temperature is to liberate carbonic acid from them. Sulphuretted hydrogen plays only a small part if any, in this process. Any remarks which I have made with regard to the want of stability of the gas bubbles supporting rising or floating minerals with regard to the Delprat process apply equally to the Potter process. They are continuously bursting, and the destruction of each bubble involves the return of the mineral to the bottom of the vessel. The same remarks made about Delprat's process in comparison with the process of the patent in suit apply also to the comparison of this process with the process of the patent in suit. Potter does not use any oil, he does not introduce by brisk agitation air into the pulp; such *as* agitation would be absolutely fatal to Potter's process and would lead to no result.

I have made a number of experiments to study the result of the Potter process. I observed that the lifting was always due to gas

bubbles attaching themselves with one part of their surface to mineral particles, whilst the remainder was usually clear. I do not mean to say that each gas bubble carried one particle of mineral; there may be a number of particles attached to one gas bubble, but I always noticed that a part of the film was not covered. These loaded gas bubbles were very tender. They frequently burst and the minerals sank again. The dropping of the mineral took place both within the liquid and after the bubbles had arrived on
562 the surface. If the stirring was anything but very slow, nothing would rise to the surface. I made one quantitative experiment. 400 grams of Broken Hill tailings, 1000 cc. of water containing 2½% of sulphuric acid, were heated to 85° Centigrade, and the mixture was slowly stirred. After two minutes' stirring, the minerals which had appeared on the surface were taken off, filtered, dried and weighed. The weight was 37 grams. The residue which remained after the froth had been removed was freshly acidulated with sulphuric acid, but so little minerals appeared on the surface that the quantity was not sufficient for further assay.

The remarks made by Dr. Byrnes, on page 136 of Defendant's Record, are absolutely incorrect and a meaning is introduced which is not contained in the specification, and a fact is stated which is equally absent in the description. Dr. Byrnes says:

"The free use of an agitator of this type causes the solution to become thoroughly aerated and impregnated with fine air-bubbles."

I cannot find any such statement in the specification, but from my experience I say deliberately that, if such agitation were used in connection with the Potter process, the result would be nil. The words actually used by the patentee are

"The stirrers are then freely used,"

563 which, when interpreted with Figure 1 of his plant, clearly show that he means "freely" in the sense of continuously, simply bringing mineral particles continuously from the middle of the ore to the top, so that they can rise to the surface after the attachment to gas bubbles. If the agitation were used which Dr. Byrnes attempts to read into Potter's specification, the result would be nil, as I said before; in other words, nothing would stay on the surface and the purpose of this invention, namely, the separation of minerals from the gangue, could not be achieved.

19 Q. Please now give consideration to the patent to Glogner, No. 736,381, issued August 18, 1903, for a Process of Purifying Graphite.

A. This patent describes a process of separating graphite from a graphite ore having earthy admixtures only, and the process consists in adding to a mixture or, as he calls it, a thin paste obtained from the graphite mineral and three or four times its weight of water, one half the quantity of petroleum of the amount of pure graphite contained in the graphite mixture, and stirring the whole thoroughly within a closed vessel. He defines what he means by thorough stirring, namely, having closed vessels suspended on chains which are

moved by short shocks, thirty in a minute, one workman being able to attend four of these vessels. The graphite is taken up by the petroleum, whilst the earthy admixture remains in the gangue. The result, that is, the separation of the graphite from the ore,
564 is due to the oil flotation; that is, the combined mixture of petroleum and graphite is lighter than water. Water is finely sprayed on the surface of the petroleum to sink any earthy particles which might be present in the petroleum. The mixture of the petroleum and graphite is then removed and the shaking of the vessel is repeated, once, twice or oftener, each time after the addition of fresh petroleum.

The remarks made by Dr. Byrnes on page 130 of Defendant's Record are particularly unfortunate, in view of the very accurate description of the process contained in the patent. Dr. Byrnes calls 30 shocks per minute a strong agitation, which is not only designed to intimately distribute the petroleum throughout the pulp, but also to aerate the pulp and cause the oiled mineral to float to the top as a froth. What the patentee describes is that by his stirring the petroleum is broken up into small drops or perles and every particle of graphite, when touching them, is attracted, whilst the earthy particles, which have been saturated with water, before the addition of petroleum, remain completely neutral; that is, are not attracted by the petroleum. What is more, if the inventor had contemplated a froth process, he surely wouldn't have destroyed the object of such an invention by sprinkling water on the surface of the oil. Furthermore, this is a process which depends on the reduction of the specific weight of the substance by mixing it with a much lighter body. The mixture of petroleum and graphite is lighter than the water and floats on it. There is not a word
565 in the specification referring to aeration, and what is more, there is no aeration. As to Dr. Byrnes' remarks,

"Agitation by 'a strong rotating * * * movement,' as suggested, is a type of agitation employed in the patent in suit to form a froth,"

I will say that I absolutely disagree with him and I feel compelled to add that it surprises me. To compare a stirring, which consists of thirty shocks a minute, with a brisk agitation used for the beating in of air into a liquid and operating at anything from 500 to 2,000 revolutions per minute, according to the size of the apparatus used, does not appear to me permissible.

Glogner's process is practically identical with the first Elmore process, only he prefers to use petroleum instead of thick oil, and the result he obtains is identical with Elmore's result, namely, a recovery of the mineral by oil flotation. The similarity goes even farther. Like Elmore, he has to retreat his gangue and has to add new quantities of oil each time he repeats the extraction of the mineral. Elmore uses for mixing the oil with the mineral a rotating motion, Glogner obtains the same rotating effect by sharp shocks.

Neither of them uses any acid. There is absolutely no similarity between Glogner's process and the process of the patent in suit.

Adjourned to Thursday, October 17, 1912, at 10:30 in the forenoon, at the same place.

566 New York, October 17, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 19 Q. continued: I have carried out the process of the Glogner patent, using the proportions and the conditions of experimentation described therein.

In a bottle 50 grams of ore containing 10% of graphite were made into a thin paste with 150 c. c. of water, and 2½ grams of petroleum were then added. The mixture was shaken with short shocks about thirty to the minute. The top of the liquid was then a smooth surface of petroleum carrying graphite. Underneath were some little globules of oil carrying graphite. There was no froth whatever. The gangue at the bottom was not quite cleared of graphite.

This experiment proves clearly and definitely that the theory advanced by Dr. Byrnes on page 130 of Defendant's Record, namely:

"The waves formed by reciprocating the agitating vessels in short shocks would naturally entrain and intermingle with the pulp a large amount of air in the form of bubbles, just as an ocean wave entangles air and forms a floating froth or foam,"

is unsound and not in accordance with the actual facts. No intermingling with the pulp of a large amount of air in the form
567 of bubbles takes place and no froth whatsoever is formed.

This is equally true of the remarks of Dr. Byrnes on page 170 of Defendant's Record, which makes the following statement:

"Glogner, 736,381, illustrates an oscillating agitating vessel, in which the mixture of ore-pulp and water is thrown violently against one end of the vessel, the wave falling back through the air, thus imitating the aeration and frothing produced by an ocean wave."

20 Q. Please now give consideration to the patent to Good, No. 745,960, issued December 1, 1903, for Apparatus for Separating Graphite or other Materials from Associated Impurities.

A. This patent describes an apparatus for separating graphite and other materials. The patentee, however, mentions only graphite specifically, but does not define the other materials. The apparatus combines the functions for the performance of three processes and consists of three parts,

(1) a part which is for the separation of finer particles or flakes by skin flotation;

(2) another part which is for the treatment of the finer particles which have been separated from the ore before it was submitted to

the operation in the first part, together with the unfloated ore from the first treatment; the separation of the graphite from the
568 ore being effected in this second part of the plant by oil flotation in a tank filled with boiling water. The coarser graphite, some oil and the sand remain at the bottom of this tank and are treated in

(3) a third part of the apparatus. The graphite in the mixture is crushed under water between two rotating wooden blocks which have sufficient power for the crushing of the graphite, but do not crush the sand. The mass is discharged over a screen into a trough. This screen retains the sand but allows the passage of the graphite. The latter is carried from this trough through a conduit into a settling tank. The processes carried out in the three divisions of the apparatus can only be

(*a*) Skin flotation,

(*b*) Oil buoyancy flotation,

(*c*) Grinding of only the graphite present in the mixture of coarse graphite and sand, separation of the so-ground graphite from the sand by a screen, and settling of the graphite in a settling tank.

No details whatever of the second and third processes are given, but, as far as their character can be determined from the construction of the plant, they can only refer to the use as mentioned under (*b*) and (*c*). The rotary agitator, described in part (2) of the plant, is used for a slow rotation to produce an effect similar to the
569 Elmore process. The oil flotation of the graphite takes place in the same tank in which the agitation takes place, and the oil containing the graphite is removed from the tank by pushing it over the lip of the tank into another tank. If there were brisk agitation, this would be quite impossible, as gangue would be likewise carried over and the very objects of the process defeated. As I have said before, the patent describes no process, at least as to parts (2) and (3) of the plant, but an apparatus. There is not a single word in it which would convey, even to the most acute intellect, the faintest idea of complainants' process and result, and even with our present knowledge it is absolutely impossible to carry out complainants' invention in this apparatus.

21 Q. Please now give consideration to the patent to Wagner, No. 373,113, issued November 15, 1887, for a Churn.

A. This patent describes an apparatus suitable for churning. On page 196 of Defendant's Record, Dr. Byrnes says, with regard to this patent:

"It is common in the production of butter to churn and beat air into the milk, the air diffused throughout it acting to throw down the curd and separate it from the butter."

This remark strikes me as being particularly inappropriate and unsuitable. The purpose of a churn for agitating cream is
570 not to produce a butter froth in which air particles or bubbles are lined with butter. It is for the opposite purpose, namely, for producing the solid butter without air. I cannot pass over a remark which is contained in the same passage and which refers to the production of an aerated soap suitable for floating on water.

Again, the use which Dr. Byrnes makes of this process does not apply to the process of the patent in suit. The soap is aerated in a liquid condition and the air is impregnated within the liquid soap. There is no separation as a froth of a heavy solid body by means of oil, and much less by minute quantities of oil and aeration.

I have read the article on "Flotant Soaps" referred to by Dr. Byrnes, which has just been handed to me for the first time, and I find that it is in agreement with what I have said.

A simple agitator called a "twirling fan" is shown for agitating the liquid soap. I do not think this would be a very good agitator for aerating an ore pulp. The same is true of the churn dashers of the Wagner patent.

22 Q. Please now give consideration to the patent to Stoveken, No. 729,805, issued June 2, 1903, for Apparatus for Extracting Metals from Ores.

A. This patent relates to the extraction of gold by the cyanide process from ores. The process involves a chemical reaction, namely, oxidation in the presence of a soluble cyanide, and the oxygen is supplied from its cheapest source, namely, from air, which is according to this process introduced by agitation.

571 I am in agreement with Dr. Byrnes in the following statement on page 175 of Defendant's Record:

"It is common practice in the art of treating minerals by the cyanide process to thoroughly aerate the ore-pulp, by a variety of methods, for example by injecting streams of air; by flowing the pulp over an aerating surface, in a thin sheet, in contact with atmospheric air, or by beating air into the pulp by an agitator."

In the cyanide process the only thing which is essential is that the air should be present and the only difference which can result from a different mode of introducing it can be a slightly slower or quickened chemical action.

The Stoveken agitator, if constructed sufficiently strong for the requirements of the agitation froth process of the patent in suit, could probably be used as the agitator.

23 Q. Please give consideration to the patent to Kendall, No. 771,075, issued September 27, 1904, for Separation of Mineral Substances by Means of the Selective Action of Oil.

A. I quote from this patent as follows:

"According to this invention crushed graphite-containing material—for example graphite ore or graphite waste—is mixed with water and brought intimately into contact or thoroughly

572 mixed with pure thin oil—as, for example, kerosene or paraffin oil—which adheres to and by reason of its levity, separates the graphite substance (this may be more or less pure graphite) from associated rocky matter, which by reason of its weight and non-affinity to oil sinks and is conveniently carried off by the water. The graphite substance is or may be afterward separated from the oil and the latter is or may be used again in subsequent similar operations."

This process is clearly an oil buoyancy process. The oil and graphite float on the water because they are lighter than water, just

as cork floats on water. It has nothing to do with the process of the patent in suit.

I note that, although the defendant has put this patent in evidence, no witness for defendant has described it or referred to it.

24 Q. Please now give consideration to the patent to Cattermole, No. 777,273, issued December 13, 1904, for Separation of the Metallic Constituents of Ore from gangue.

A. This invention relates to improvements in the separation of the metalliferous constituents, that is, minerals present in ores, from the gangue, by means of the selective action of oil or certain coal tar products which are classified as oils. The invention depends on the following facts:

573 (1) An oil suspended in water has more or less selective action. It will coat the particles of metalliferous matters in preference to the particles of the gangue. In other words, the values will be coated with oil, the gangue will be wetted by the water.

(2) The presence of an acid in the mixture of the oil and the pulp will increase the selective action of the oil and render it more marked and decisive.

(3) If the proportion of the oil is kept within reasonably low limits (the quantity of oil to be used in different cases may vary according to the nature of the ore to be treated and according to the consistency and nature of the ore), and if the mixture of water, oil and ore is thoroughly agitated, the minerals became coated with oil and will adhere together, forming granules which, partly by reason of their gravity, partly on account of their bulk as compared with the individual mineral particles before this treatment, settle on the bottom of the agitating vessel when the agitation is stopped. The inventor has further discovered that this granulating action is facilitated if the oil, before the addition to the pulp, is emulsified with water containing a small amount of soap or other emulsifying agent.

On these three facts the inventor has based his very ingenious process for the separation of minerals from ores in the form of granules. The process is as follows: In a convenient apparatus the finely powdered ore is violently agitated, for instance, by a revolving stirrer, with the mixture of acidulated water and oil.

574 By the process of agitation the mineral particles agglomerate together in the form of granules, which, when the agitation has ceased, will fall to the bottom of the vessel and which are so heavy that they can be removed from the sand in a simple way, by up-current of water, which carries the sand and will not carry the granules along with it. The continuous process devised by the inventor is performed as follows: four mixing vessels, which are in series and which are provided with stirrers, are filled with the ore pulp, the oil emulsion, and a small quantity of acid. The circuit is filled with acidulated water and turned up in such manner that the inflowing pulp and oily mixture will be corresponding to the overflowing water. Agitation is started and the pulp and oil mixture containing a small proportion of acid are allowed to run into first

mixer, from which it passes into the following mixers. The well agitated mass, on leaving the fourth mixer, enters the vessel called by the inventor a classifier, which is provided with an up-current supplied through a pipe at the bottom through which acidulated water enters. The granules which have been formed in the agitator and separated in the classifier fall, in consequence of their greater falling power, with a certain quantity of the coarser gangue, to the bottom of the classifier and are removed from there through a pipe into another agitator, whilst the lighter sands are carried away by the upward current and discharged into a setling tank. In order
575 to separate the granules from the heavy sand, the mixture is further agitated in the mixer, of which there are two in series, and then pass into a second classifier and the falling power of the granules has been so much increased that the up-current introduced in the classifier will be regulated in such way as to be able to carry away the heavy sand, whilst the granules are discharged from the bottom of the classifier into another tank. The inventor states that this apparatus is only a type and serves as an illustration. It can be varied considerably and also the steps of the process may be varied. The mixers shown in the drawings are of a well known type, namely, the cone or Gabbett type. They are shown as a diagrammatic sketch. In 1904, they were well known mixing and agitating devices. I have known them as "cone mixers" for many years before 1904. I knew them as cylindrical vessels with baffes.

Cattermole has described in the text of his patent a rolling form of agitation as preferably to be used in some stages of the process to obtain a good granulation of the mineral, this rolling to be such as is had in cylinders or barrels. This appears at page 3, lines 46-50. This is not shown in the drawings. Of course, a cylinder or barrel could be used in place of any cone mixer which is shown, and it would be reasonable to put cylinders or barrels in place of the last two cone mixers. Indeed, it would be self-evident that this would be the place to use the rolling form of motion, as the first set of cone mixers could then be relied upon to intimately mix the oil
576 with the mineral.

The proportion of oil used depends on its viscosity, the fineness of the ore and other factors, and on the consistency and size of the granules desired. The more oil used, the larger, softer and less numerous the granules. With 10% of oil to the weight of minerals, only a few pasty masses of oil agglomerated minerals will be generally obtained, and oil in excess of this quantity may cause all the granules to coalesce into one soft mass. Cattermole recommends a quantity of oil between 4 and 6 per cent. of the weight of the metalliferous mineral matter present in the ore, but this is only a recommendation and a statement of what he has usually found to be necessary. It is clear from this description that a definite amount of oil to produce good granulation effects cannot be given, as the final result is determined by many factors which have to be first experimentally ascertained. No definite law of proportions can be laid down for this process, which is a process for the treatment of a large class of substances, each differing from the other

in many ways, and is in that respect like all other processes which are destined for the use of differently constituted compounds and not for the use of one individual substance. But the patentee has described his invention so well and exhaustively that a few experiments will suffice to determine the proper proportions suitable for a given ore.

The amount of emulsifying agent should be from 3 to 5
577 per cent. of the weight of oil and as substances suitable for emulsifying processes, soap solutions of low alkalinity are recommended, but a large number of others are mentioned. A specially beneficial action in granulation is claimed for the acid liberated by sulphuric acid from the emulsifying agent.

The inventor describes further the process for the recovery of the oil from the granules. The oil is removed from the granules by agitating them with the emulsifying agent in a stronger or more active condition or proportion than is used for the emulsifying of the oil initially, and the stripping action of the emulsifying agent is increased by attrition of the granules.

Where water is scarce, it is recommended that the wet crushed ore is allowed to settle and that only the wet ore is fed into the agitator, and in this way the circuit can be kept distinct from that of the mill water. Wherever an ore is intended after crushing for further treatment with water, it is usual to crush it wet, as in this way great inconvenience is avoided. That is not only so with ore, but with many other products.

The inventor gives a warning that ores containing little mineral should be enriched for treatment by his process, in the following paragraph (Spec. page 3, lines 34-43):

"In certain cases, as where but little mineral is present in the ore, to increase the nucleating or granulating factor, pulverized mineral matter obtained in a previous operation or other matter hav-
578 ing an affinity for oil from a different source may be introduced into the ore, or a portion of already granulated and separated mineral matter may be returned to maintain the necessary amount of mineral in the ore under treatment."

Adjourned to Friday, October 18, 1912, at 10:30 in the forenoon, at the same place.

New York, October 18, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 24 Q. continued: I performed an experiment with regard to the Cattermole invention described in this specification. I took 500 grams of Broken Hill tailings, 30 cc. of an emulsion containing 10 grams of Texas fuel oil and an amount of resin soap (Primrose soap) of 3.3% of the weight of oil, and stirred them violently in a cone mixer with 1500 cc. of water and 30 cc. of sul-

phuric acid. The mixture was allowed to flow whilst being agitated, into the center of a vessel, into which water was running up from the bottom and running out at the top charged with slimy sands. The vessel had an opening at the bottom, from which the minerals which were as granules quite at the bottom and the coarser
579 gangue were emptied out and then put back into the cone mixer, from which however, the baffles had been removed. They were there slowly rolled for about eight minutes and collected again as before. In this operation, part of the sand again was removed. The experiment proved the absolute correctness of the specification and of the description of the result.

25 Q. Please now give attention to the patent to Cattermole, Sulman and Picard, No. 777,274, issued December 13, 1904, for Concentration of Minerals from Ores.

A. This patent is a modification of the process of the previous patent, and the modification consists in the use of oils or oily substances which form combinations with alkalis, such combinations being alkaline salts, and in producing the fatty acids therefrom in situ. Types of such alkaline salts are ordinary soaps, and alkali salts of certain aromatic derivatives, such as cresols, phenols, etc., which on addition of acids liberate the oily or aromatic substances. The apparatus used is identical with the apparatus of the previous patent and the process equally so, with the exception that the fatty acid is produced as stated in situ. The result is agglomerated masses or, as they have been called, granules.

This patent is known among the staff of Minerals Separation, Ltd., as the soap and granulation patent.

26 Q. Please now give consideration to the patent to Cattermole, Sulman and Picard, No. 788,247, issued April 25,
580 1905, for Ore Concentration.

A. This patent includes the invention described in the previous patent, No. 777,274. It is an invention broadly claiming the granulation by means of oily substances produced from the alkali salts in situ and the separation of the granules after their formation by a number of different methods, of which the method of the previous patent is one. There are several examples given, one of which is to remove the granules by flotation. A gas is generated in the mixtures and the bubbles on attaching themselves to the granules lift them to the surface, thus enabling the oil-coated aggregates to float by the phenomenon of skin flotation, and the substance will float sufficiently long for collection, even if the gas bubbles burst. Suitable sources for the generation of gases are suitable carbonates, which may be present in the ore, or added, or an easily decomposable sulphide, which on addition of mineral acids release the gases (in the one case carbonic acid, in the other case hydrogen sulphide) from the salts. Another mode described is to make the coated mineral aggregates adhere to metallic or other suitable surfaces, coated with similar fatty acids, that is, oily substances, and still another mode is to make the coated mineral particles adhere to suitable materials lighter than water such as wood sawdust coated with similar fatty acids, that is, oily substances, by which process the minerals can be

removed by flotation. Another feature of the process of this
581 patent and of the previous patent is the fact that the oily substances can be reconverted by treatment of the concentrates with an alkali into soluble soap solutions and these soluble soap solutions can be used for the treatment of new quantities of ore, by which a great economy is effected.

The deciding phenomenon of this invention is the formation of a product which is heavier than water and gangue, that is, having such a physical character that it will actually sink in water. In the first two claims the method of separation is claimed generally and includes the process of removal of the two patents which have been discussed, No. 777,273 and No. 777,274. The second way of separation consists in lifting the aggregates of minerals up by air bubbles, not as a froth, because there is no froth whatever, but by attaching themselves to the granules and making them rise to the surface. As soon as they are at the surface, the surface tension will keep them up long enough to allow of their collection, even after the gas bubbles have disappeared. No froth in the ordinary sense, I should say, is formed, but certainly nothing which has any resemblance to the agitation froth of the patent in suit. I repeat what I have said before, that the agitation froth of the patent in suit is a froth consisting of air bubbles which are absolutely covered by an armor of mineral particles in which a clear film surface of the gas bubble is quite absent. It is a stable compound. In the
582 flotation of the products of the process of the present patent, gas bubbles may support one or several aggregates of minerals, but there is regularly a clear space left in the bubble and the bursting of the bubble is of frequent occurrence. The two phenomena have no similarity with each other.

27 Q. Please now give consideration to the patent to Salman and Picard, No. 793,808, issued July 4, 1905, for Ore Concentration.

A. This is another invention for the separation of oiled minerals by the skin flotation process, and there are several ways described to carry the invention into effect. The first step consists in adding such a proportion of oil to a pulp as will produce aggregation of minerals in the oil which are heavier than water, or, as the inventors put it, "but the quantity of oil should be insufficient to raise the oiled mineral by virtue of the flotation power of the oil alone." After the completion of this part of the process, a suitable gas is generated in or introduced into the mixture, and, as examples, air, carbonic acid and sulphuretted hydrogen, or the like, are mentioned. As suitable substances for the generation of gases bicarbonates or carbonates either soluble or insoluble in water (preferably the latter), or easily decomposable sulphides and the like, may be used with acid solution, and in such cases the addition of the acid may be made, if desired, after the addition of the gas-producing agent. Gases may be produced by electrolytic methods, or by means of various other known reactions.

583 A second way of carrying this invention into effect is to spray the oil with air or other gases into the pulp or to charge a current of air or other gases with a vapor of a volatile oil and to

introduce such gases or sprays, preferably at the bottom of the vessel containing the pulp, by means of a pipe provided with perforations or by other suitable contrivances. The inventors state that the oiled minerals have the power of attaching to themselves, with a greater comparative strength than the gangue particles, the gas bubbles, and are carried by them to the surface. The inventors then call attention to the fact that, when an oil spray is used, the temperature of the pulp should be so varied as to secure the best results with sprays of oils of varying viscosity. Furthermore, instead of introducing the oil spray in an air supply system, a suitable device of atomizing jets operated by air or by steam and air may be introduced directly into the pulp. The gases used may be other than air, such as carbonic acid, steam, or mixtures of these.

The third mode of carrying out the invention is to spray the oiled ore pulp through air on the surface of water. The gangue particles sink at once, whilst the metalliferous particles float, according to the phenomenon of skin flotation.

There are three sheets of drawings attached to the patent, which are highly instructive. The first apparatus consists of a tank containing the pulp, which flows through a pipe coming out from the bottom into a lengthy vessel less deep at the end and where
584 the pulp enters than at its other end. This vessel is provided along the bottom with a perforated pipe in the shape of a helix, which is so arranged that it can be rotated. Air can be introduced through this pipe at the shallow end of the vessel and an arrangement is provided by which the air will carry oil along with it. At the deep end of the vessel a launder is provided on the top and an outlet at the bottom. The working of this apparatus is so obvious that it scarcely requires an explanation. The pulp is fed into the vessel which contains water at the place where indicated in the drawing, the air and oil supply is turned on, and the helix, that is, the perforated pipe, is rotated. By this operation, the coating of the minerals with oil is performed, air is supplied to lift the minerals to the surface, and, after they have arrived at the opposite side of the vessel, they overflow into the launder, whilst the sand is removed through the outlet at the bottom. The result of this process is, according to my experimental observations, skin flotation.

The apparatus illustrated by the sketch on sheet 2 consists of a pulp mixer with a pipe leading from the bottom serving as an outlet for the pulp. The pipe is bent rectangularly and contains another pipe inserted which is intended for admission of air. In front of it is a system of spitzkastens, each of which has at the bottom an outlet and the last one on the top a launder, to collect the outflowing concentrates. The pulp is mixed with oil and allowed to
585 run out. It is sprayed by the air or other gas on to the spitzkasten where the gangue will sink, whilst the minerals will float by skin flotation. They are collected by overflow at the end of the system.

The sketch on sheet 3 shows a tank with an outlet which is connected with a cylindrical collar fixed around a vertical spindle, which can be rotated by a driving pulley. Fixed to the bottom part of the

spindle is a round disc, which is surrounded by a series of spitzkasten, increasing in depth towards the outside. Each of the spitzkasten is provided with an outlet at the bottom and the most outward spitzkasten with a launder to receive the overflow. The pulp is fed into the cylindrical collar and from there falls on to the disc which is being rotated. The effect of the rotation is to spread the minerals into a fine layer and propel them by centrifugal force into the spitzkasten. The gangue falls, and the minerals float by skin flotation. The concentrates are collected in the launder by overflow.

It is impossible to produce, according to the process which is disclosed in this specification, the agitation froth of the patent in suit. I have made a number of experiments with the apparatus meant to represent Figure 1 of this patent and offered in evidence by the defendant, and marked "Defendant's Exhibit, Apparatus of Patent No. 793,808." In this apparatus the overflow, marked B^4 in the drawings, which forms an essential and characteristic part of the apparatus, has been omitted.

586 Experiment I was carried out to find out whether the agitation froth of the patent in suit could be produced with quantities of oil suitable for the process of the patent in suit. A quantity of Broken Hill tailings of about 4 to 5 lbs. was fed in by hand into the vessel containing the helix, as in the model no provision was made for feeding the ore in in any other way. The oil used was oleic acid and it was sprayed in by air at a pressure of 3¾ lbs. in such manner that one drop came about every two seconds. About 6 cc. were used altogether. The acid which was used was sulphuric acid and it was present in such quantities that at the end of the operation the liquid showed distinct acid reaction. As soon as the feeding in began, the helix was rotated with a speed of 240 revolutions per minute and the rotating of the helix was continued to the end of the experiment, which lasted about five minutes. No froth whatever had formed. A skin of about six inches in length could be observed at the end of the vessel where the overflow ought to have been.

Experiment II. The previous experiment was repeated with larger quantities of ore and with quantities of oil which were sprayed in by air corresponding to two lbs. to the ton. The vessel was filled with water heated to 55° Centigrade. Sulphuric acid in proportions of 22 lbs. to the ton of ore was added to it, and the solution agitated at a speed of 240 revolutions per minute. The ore, of which 20 lbs. were used, was fed in by hand at the end near the spray. The spraying of the oil was commenced as soon as the feeding
587 in of the ore had been started. The operation of feeding the 20 lbs. of ore in required about ten minutes, but the agitation was continued for a further four minutes, and then stopped. A film appeared on the surface containing only traces of minerals (less than 50 grams) but no froth. Air was again blown in and the helix rotated for two minutes at a greatly increased speed, namely, 700 revolutions per minute. On being then stopped, again a thin film appeared containing very little mineral, about 50 grams at the most.

Experiment III was made in a different way. 20 lbs. of Broken Hill tailings were made into a pulp in a cone mixer and sulphuric acid in the proportion of 25 lbs. per ton and oleic acid in the proportion of 2 lbs. per ton of ore were added. The temperature of the water was 55° Centigrade. It was then briskly agitated for two minutes in the cone mixer and produced, after settling, a heavy, very excellent froth. The mixture was re-agitated and emptied during the process of agitation into another vessel, wherein the froth reformed again very quickly. This proved that re-agitation in a vessel provided with a suitable agitator will always re-form the froth. It was then emptied into another vessel and carried to the apparatus offered in evidence by defendant and representing the apparatus of Figure 1 of patent No. 793,808. Air was then blown in and the helix rotated at a speed of 240 revolutions per minute for five minutes. On stopping the rotation and the air blast, there was a
588 thin skin flotation, but no froth.

Experiment IV was carried out with proportions of oleic acid which fall within the Cattermole range. 20 lbs. of ore were mixed with 60 lbs. of water and 4 oz. of oleic acid (1.25% on the ore and about 4% on the mineral) were mixed in a cone mixer for five minutes. After agitation, a partial layer had formed on the top containing very little mineral. Imperfect granules, which owing to slime and not quite sufficient oil, were not as compact as the usual Cattermole granules, were at the bottom. The mixture was conveyed into the helix apparatus described in the previous experiment and the helix was rotated with a speed of 240 revolutions per minute, whilst at the same time air was blown in. The result was an aggregation of pasty particles on the surface, which floated as skin flotation.

From these experiments I conclude, which, however, was quite obvious to me from the study of the plant used for them, that it is impossible to produce the agitation froth of the patent in suit by the apparatus of Fig. 1 of 793,808 and that, however the experiments are carried out, no such froth can be produced in it. The construction of the apparatus is such that the agitation froth, if it were produced therein, would be of no benefit, because there would be no separation from the gangue, and both gangue and mineral would be emptied out together into the launder. The apparatus is clearly intended for a continuous process of the separation of minerals
589 from gangue, in which the minerals are carried in the agitation vessel during the rotation process to the top and the gangue remains at the bottom and is removed from the outlet at the end of the vessel. Moreover, the helix form of the agitator through which air bubbles are blown out at a considerable pressure cannot produce a form of agitation capable of intermingling air and pulp in such a way as to lead to an agitation froth, even on the supposition that all other conditions, and proper proportions, were fulfilled. By this form of apparatus air can be blown out, but it cannot be sucked in and form an intimate mixture with the pulp. And what is more,

not even the pulp can be properly mixed with the coil of the kind as shown in Figure 1 of patent No. 793,808.

I have read the remarks made by Dr. Byrnes with reference to this patent, which are contained on pages 138-143 of Defendant's Record. The first two pages are devoted to the quoting of a part of the specification. He then discusses specifically the apparatus shown in the three figures. Of the apparatus marked Figure 1, he says (page 141):

"This apparatus is well adapted to preferentially coat the metalliferous constituents of the ore with a minute film of oil insufficient of itself to raise the mineral, and also to attach to the oiled mineral particles films or bubbles of air to float them as a froth."

590 I absolutely disagree with this statement and am convinced, from my experiments, that this apparatus is only suitable to produce the phenomenon of skin flotation. The air which is blown through the helix, it is true, attaches itself to the oiled aggregates and carries them to the surface, but the very motion of the helix destroys the air bubbles and the particles which remain on the surface are floated as skin flotation. There may be some of these bubbles left, but to say that this form of apparatus is well adapted for the production of a froth, I absolutely deny.

As to the agitation froth of the patent in suit, that is an utter impossibility. Furthermore, I cannot quite understand what kind of a froth Dr. Byrnes means. If he wishes it to be understood that it is an agitation froth like the one of the patent in suit, then, of course, he contradicts himself in the sentence following (page 141):

"Which is then discharged over the top of the end wall of the tank into a launder, the unoiled gangue remaining at the bottom of the tank whence it may be withdrawn through a tap."

An agitation froth such as the froth of the patent in suit does not separate whilst agitation is proceeding, the gangue at the bottom and the mineral at the top. If he calls the lifting to the top of one or several particles of minerals by a gas bubble, a froth, then I say this is not a froth. Or if he calls the bubbles of air which are propelled from the helix and come through the surface of the water

591 with considerable force, a froth, I again disagree with the term, although there would be no difference of fact. As the passages quoted from Dr. Byrnes are not sufficiently clear to explain what he means, I have stated the facts as I found them by experiments.

I further quote from Dr. Byrnes' testimony (page 141):

"The coiled perforated pipe will also act as an efficient agitator to entangle and intermingle a considerable amount of atmospheric air with the pulp, assisting the aeration."

Again this passage is obscure and it does not state whether Dr. Byrnes means that this form of agitation is an agitation which will draw in air from the atmosphere, or whether he means that this form of agitation and the air introduced through the pipe is an especially good mode to intermingle a considerable amount of atmospheric air with the pulp. I disagree with both propositions. As to the first, I say, it is practically the worst apparatus conceivable

for drawing in air from the atmosphere, and, as to the second, I say, it is a very bad agitator for producing an intimate mixture of pulp and air, but it is an excellent apparatus for the purpose for which it was used by the patentees, namely, for slowly turning the oiled pulp and giving the air bubbles time to perform their duty,
592 namely, lifting the oiled aggregates of minerals to the surface. A quick agitation is fatal to it.

Adjourned to Monday, October 21, 1912, at 10:30 in the forenoon, at the same place.

New York, October 21, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 27 Q. continued: The use of the apparatus illustrated by Figure 1 of No. 793,808 is intended by the patentees only for spraying oil by means of air into the pulp. That is obvious both from the sketch and from the text, page 2, lines 31-34. My efforts to use it for this purpose were futile, and I could not produce any results therewith. I did not succeed in oiling satisfactorily the pulp by this apparatus and I do not believe that it can be done. My failure to get satisfactory results by using the apparatus of Figure 1 induced me to change the mode of operation as described in Experiments III and IV. I am aware that this description is not contained in the document, but the method which I adopted has been also used, but with larger quantities of oil, by the patentees as shown by the testimony.

593 The quantities of oil to be used in the different processes of this patent are within a very wide range, but the fundamental condition is that the solid particles shall be "moistened" by the oil (Spec., page 1, line 19). That is the lower limit. The upper limit is that the patentees do not desire buoyancy flotation or, as they express it, "in quantity insufficient to raise the oiled mineral by virtue of the flotation power of the oil alone" (Spec., page 1, lines 25-27). This means that the quantity of oil must be less than is required to make the mixture of oil and minerals of lighter specific gravity than water. Of course, the quantity of oil necessary for such purpose is not a constant; it depends on the quantity of minerals present and their character and specific gravity, but, roughly speaking, it always will require for average ore oil in quantity about three times the weight of ore, that is, about 6,000 pounds of oil to the short ton of ore. I should say that the quantities intended to be used by the patentees were somewhere between Cattermole and some indefinite limit upwards. I have made some experiments with quantities of oil as disclosed by the patent in suit. It must not be understood that I made these experiments as experiments relating to this patent No. 793,808. There is no suggestion in 793,808 of such quantities to be used. The contrary is the fact and quantities

as described in the patent in suit were absolutely unknown and undreamt of at the date, October 5, 1903, when the application for
793,808 was filed. The reasons why I tried to make use of
594 the apparatus of Figure 1 of No. 793,808 with quantities of oil as described in the patent in suit were the statements in Dr. Byrnes' evidence, which so utterly surprised me and were so much in contrast with my own experiments that I tested the apparatus not only as described in No. 793,808, but also with the quantities described in the patent in suit. I was simply trying to find out whether the apparatus of Figure 1 of 793,808 could, by introducing the later invention, be made to produce the results which Dr. Byrnes has described on page 165 of Defendant's Record. But, as recorded in my experiments, I failed absolutely. I could only succeed when I mixed the pulp in a cone mixer with oil in quantities large enough to moisten the mineral and then submitted the mixture thus obtained in the apparatus of Figure 1 of 793,808, to air, which was introduced through the perforations of the helix whilst it was being turned.

I disagree with Dr. Byrnes in his remarks about Figures 2 and 3 of 793,808 contained in Defendant's Record, on pages 141, 142, and I say that these apparatus will not produce a froth, but skin flotation, and that they are only suitable for such purpose.

28 Q. Please now give consideration to the patent to Schwarz, No. 807,501, issued December 19, 1905, for a Process of Concentrating Ores.

A. This patent describes a process for converting oxides and carbonates of metals into sulphides, and the invention is based on the fact that it had been observed that sulphides have a greater
595 affinity for hydrocarbons as adhesive agents than oxides or carbonates. As a matter of fact, the patentee states that the concentration of minerals contained in ores by means of hydrocarbons has been largely confined to sulphide ores. The oxide or carbonate of a metal contained in the ore is treated either hot or cold with a soluble sulphide in a suitable vessel provided with an agitator. The second part of the patent deals with the concentration of the ore after the mineral has been converted into a sulphide. This process is practically identical with the process contained in 807,503, which latter patent deals exclusively with the treatment of ores for the concentration of minerals by an oil process, and I will consider this second part of 807,501 when dealing with the invention contained in 807,503.

29 Q. Please now give consideration to this second patent to Schwarz, No. 807,503, issued December 19, 1905, for a Process of Concentrating Ore.

A. This invention relates to a process for the concentration of minerals in ores by means of a selective material consisting of a compound or mixture of either mineral, vegetable or animal oil with a fatty matter which is solid at ordinary temperatures, such as paraffin, stearine or palmitine. The inventor states in his introduction his view of the state of the art. He says that the separation of the values in ores have been effected by mixing the pulverized ores with a product resulting from the distillation of petroleum,

596 the ore having been previously mixed with sufficient water to form a freely flowing pulp. The process previously used consisted, therefore,

(*a*) in the making of a pulp;

(*b*) in the treatment of such pulp with the product resulting from the distillation of petroleum.

In the invention described by the patentee the process consists of the following steps:

(*a*) Mixing of the ore with the selective agent consisting of a mixture of an oil with a solid fat or fatty body; such mixture being solid at normal temperatures; and the mixing has to be performed at such temperatures that the oil is liquid;

(*b*) After complete incorporation of the selective material with the ore, water is injected into the mass and the agitation continued until the water is distributed through the mass;

(*c*) The action of the selective material is facilitated and better results secured by the injection of gaseous fluid, such as air, steam or gas, into the mass. These three steps are the essential part of Schwarz's invention, and he describes an apparatus in which it is to be carried out.

The ore is mixed with sufficient of the selective material to make a thick, pasty mass in a vessel, steam jacketed or otherwise suitably heated. As selective material, a preference is given by the inventor to crude petroleum or any of its products, with admixture of 9 to 10% of paraffin. After complete incorporation of the selec-
597 tive material with the ore, water is injected until it is distributed throughout the mass, which is accomplished by agitation. The mass is then allowed to subside, when the selective material with entrapped metallic constituents will rise to the top and may be removed in any suitable manner, for instance, by floating over the top of the vessel. This description can only refer to an oil buoyancy flotation. That this view is right is confirmed by the next sentence (page 1, line 70):

"The values may be separated from the selective material in any suitable or well-known manner—as, for example, by a centrifugal durm or filter-press."

The oil is present in such quantities in the concentrates that its recovery, either by filtration through a filter-press or by means of centrifugal apparatus, is described as a matter of course. He continues to say that the separation above described is assisted by the injecting of air, steam or gas, such as carbon dioxide, into the mass. By the term "mass" he clearly understands the mixture of ore and oil, and it is another indication of the very large quantities of oil which must be present. I must express my surprise at this point about an experiment described by Dr. Byrnes on page 162 of Defendant's Record. He mixed 500 grams of ore with 20 cc. of cotton seed oil, the mixture having the consistency of molding sand. I cannot conceive how Dr. Byrnes imagined that that was Schwarz's
598 invention and how he thought he could blow air through a mixture of the consistency of molding sand and what the

effect would be if it could be done. I shall have to criticise his experiment later on and will therefore go back to Schwarz's invention.

The effect of the injection of air, etc., into the mass is completely to subdivide it and break it up, and it results in the selective material taking up an appreciable quantity of air or gas which, giving a certain sponginess, increases its floating power. The intention of the inventor is quite clear. Air bubbles are retained in the viscous oil and are as such instrumental in reducing the specific gravity of the mixture of oil and mineral. After the addition of water, which is carried out by suitably arranged pipes, the addition of air is continued in order to assist in the distribution of the water throughout the mass and to effect the thorough separation and washing out of the tailings.

The separation of the concentrates can be effected, the inventor states, in two ways. If cold water has been employed in the process, then the selective agent will be solidified and enclose the minerals and will rise to the top and will be conducted from there by a trough to a remelting and storage vessel. If heated or boiling water has been employed, the selective agent will be maintained in its liquid condition and will be run with the metallic constituents entrapped therein into a storage vessel. Whether the minerals are collected entrapped in the solid selective material, or in the heated
599 fluid selective material, the oil is separated from them in the first case after remelting of the oil by the process of filtration, which again indicates the large quantity of oil used in this process.

An apparatus is described to carry the process into effect. The powdered ore flows through a hopper into a vessel, preferably steam jacketed, and provided with an agitator. In this vessel, the ore is mixed intimately with the oil and then flows through a trough into another vessel. That the mixture can be conveyed in such a simple manner from one vessel into another is again a proof of the large quantity of oil which must be present in the mixture. The second vessel is again provided with an agitator and serves for the purpose of the treatment of the oil mixture with water, which latter may be acidulated. This vessel is provided with pipes for the introduction of air, steam or gas, and with a pipe for the discharge of the tailings. After the separation, the oil with the minerals is run into a storage vessel in which, if solid, the oil has to be remelted, then it is taken from there to a centrifugal drum for the separation of the values from the oil.

A careful consideration of this invention makes it absolutely clear that it is an oil buoyancy flotation process, the buoyancy of the oil being increased by introducing into it some air which will remain mixed up with it in consequence of the viscosity of the oily mass. The novelty in the invention is the selection of a specific mixture made from two component oily substances, which results in
600 a solid, and the use of such solid in such way that the resulting mixture of oil plus mineral can be collected and separated either as a liquid containing the mineral or as a solid containing the mineral. Another feature of the invention is the increase of the

buoyancy of the oil, that is, of the carrying power of the oil, by aerating the oil and enclosing air bubbles within the oil.

I have said in the discussion of the Schwarz patent previously described that the process of the former patent and of this patent, so far as relates to the separation of the minerals from the ore, are identical, and I repeat this. The other patent considers as the essential feature of the invention the conversion of an ore, such as oxides, carbonates and chlorides, into sulphides, to render them suitable for the treatment by hydrocarbon, which means an oily material. It is well known that generally such minerals as sulphides were substances suitable for treatment with hydrocarbons or oils, and the idea of the inventor is to make other minerals suitable for the same kind of process by converting them into sulphides. I have not carried out such a conversion and I cannot speak as to its result from personal experience. But the possibility of concentrating sulphides by an oil process depends solely on certain physical properties. It is not a chemical process. Sulphide ores as occurring in nature have got these essential properties, but I have grave doubts whether a sulphide as proposed to be made by the process described in Schwarz's
601 first patent will be suitable for an oil treatment to make concentrates of the minerals. Sulphides produced by the action of solutions of sulphides, such as sodium sulphide, have usually quite different properties from the sulphides in nature. The latter are crystalline products of metallic lustre, looking just like metals. The sulphides made in the laboratory or in works by precipitation or conversion, are amorphous products, which cannot be mistaken for metals and which have none of those characteristics which I enumerated as belonging to the sulphides found in nature.

I have read the conclusions drawn by Dr. Byrnes from this specification and the facts which he finds revealed in it on pages 146, 147 of Defendant's Record. I disagree with most of his statements and they strike me as an essay not dealing with the exposition of a perfectly plain and straightforward invention, but how to disguise these plain facts and make them appear as something quite different, of which there is not a grain of substance contained in the patent. As to paragraph (3), I say that it is ambiguous and does not express the true meaning of that part of the patent which refers to it. It reads:

"The use of a sufficient quantity of the oil or oily mixture to effect the desired separation, that is, the oiling and floating of the metalliferous constituents."

The patentee directs the use of a quantity of oil sufficient to
602 form with the mineral a thick, pasty mass, which, as the oil is solid, may mean a large quantity, sufficient that the oil can be recovered by filtration, sufficient that it can carry the mineral and still float, sufficient that it can enclose, when solid, the mineral and still float. These are the directions I find in the patent and they all indicate a considerable quantity of oil to be used. The statement of Dr. Byrnes as it stands would include the quantities of the agitation-froth process. I scarcely need add that even the wildest imagination cannot discover any other process in this patent but the oil

buoyancy flotation, assisted by the enclosure of some air bubbles in the oil.

I disagree with the facts and the conclusions drawn in paragraph (5). The mechanical agitation referred to in the patent can only be a comparatively slow one, as it is very difficult to agitate quantities and proportions as they would occur in the mixing of oil and minerals, even if the quantities of oil are such as are required for oil flotation, and there is no difference mentioned in the specification between the mixing of the oil with the minerals and with the agitation for distributing the water through the mass of ore and oil. It simply says, the agitation is continued. I disagree with the statements contained in paragraph (6). There is not a word mentioned of the formation of a froth. What the patent says is that the selective material, that is, the oil, takes up an appreciable quantity of gas, which gives it a certain amount of sponginess, which in-
603 creases its floating power, that is, the floating power of the oil, by the enclosing of bubbles of air within the oil.

As to paragraph (8), after "the centrifugal filter" the addition ought to be made: for the separation of the concentrates and the recovery of the oil.

The experiments described on page 162 of defendant's Record have no similarity whatever to the process described by Schwarz. Dr. Byrnes used 500 grams of defendant's ore and mixed it with 20 cc. or, in weight, about 18 grams of cotton seed oil. I should like to know how this mixing was effected. I cannot conceive, unless there was some special device, how he could mix 500 grams, that is 125 cc., of a dry powder, with 20 cc. of liquid. The result had the consistency of molding sand, i. e. of an almost dry powder. The patent directs you that you are to have a thick, pasty mass. The mixing of a pulp with 3.6% of oil is an easy matter. There you have a large quantity of water with it, and by brisk agitation you break the oil into small particles, which are then capable in another medium, namely, water, to perform the function of coating the mineral. But to mix 500 grams of ore, which if it was a solid block would fill a space of 125 cc. but which, being in very fine division, presents an enormous surface, with 18 grams or 20 cc. of oil, seems to me a very difficult operation. The function of the oils, according to the description of this process, is to carry the minerals. Taking the percentage of minerals to the ore to be 30%, the 20 grams of
604 oil, after solidification, have embedded in it 150 grams of minerals. I need not comment on this. These 20 grams are then remelted and the oil separated by a centrifugal drum or by a filter press. How the process is carried out of separation by filtration of 20 grams of oil from 150 grams of mineral, I do not know. I should like to add, that the patent provided for an apparatus for mixing the ore with oil. It is an ordinary agitator. I feel inclined to say from practical experience of such apparatus that the agitator would refuse to work with quantities as used by Dr. Byrnes. Dr. Byrnes then mixed this oiled mass with 1700 cc. of water acidulated with 1 cc. of sulphuric acid, the water having a temperature of 76° Fahrenheit, and agitated it for the purpose of aeration in the

apparatus which he calls the Hyde slide machine. These are not the directions of the patent. The patentee directs you to aerate the mixture of ore and oil and not the mixture of air, oil and water, and to do this by introducing air through a set of pipes into the mixture of ore and oil. To pass air through pipes into a mixture of ore and oil having the consistency of molding sand, would soon put a stop to the introduction of air. If the pressure were strong enough, the air would force an opening through the mixture and pass out without any benefit to the mixture; or, if the pressure is not strong enough, the mixture would stop up the pipe. That my contention is right is shown by the following passage (Spec., 807,503, page 1, lines 85-100):

605 "This may be done by suitably arranged pipes leading into the bottom or sides of the vessel, the effect of such use of air, steam, or gas being to break up and subdivide the mass in a complete and thorough manner. Furthermore, it results in the selective material taking up an appreciable quantity of air or gas, giving a certain amount of sponginess, which increases its floating power. After the admission of water, which may be done by suitably arranged pipes, *the admission of air, steam, or gas may be continued* to assist in distributing the water throughout the mass and to effect a thorough separation and washing out of the tailings." (Italics mine.)

Dr. Byrnes agitated for 30 seconds, at a speed of 1600 revolutions per minute, and says that a heavy froth was produced, which he removed. I have never seen with such quantities of oil the production of a heavy froth. He removed the first froth and repeats the operation of agitation and production of froth six times and these froths were combined and assayed. I have carefully gone through the specification to find any passage which might warrant him to carry out the Schwarz patent and the treatment of the tailings remaining after the first separation in the way he did. The only passage that I can find is contained on page 1, line 73, et seq., and reads:

606 "The tailings, being unaffected by the selective material, will remain in the water and settle to the bottom of the vessel, from which they may be drawn off and, if necessary, subjected to further treatment for the recovery of any values they may contain."

What the patentee directs you to do is to withdraw the tailings and subject them, if necessary, to further treatment for the recovery of any values which they may contain. In other words, as I understand this passage, the tailings are either added to the next lot to be treated or are treated by themselves by the process as described in the specification. This would mean that they are to be again mixed with the quantities of oil required by Schwarz. Dr. Byrnes re-treats them without adding any oil and thus gets rid of a great deal of his oil. Whatever results he obtained, he was not carrying out the Schwarz specification.

Adjourned to Tuesday, October 22, 1912, at 10:30 in the forenoon, at the same place.

607 New York, October 22, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 29 Q. continued: The experiment described by Dr. Byrnes on page 162 of Defendant's Record as being a performance of the process contained in Schwarz's specifications, 807,501 and 807,503, does not carry out the inventions described in these documents and is utterly different from the process described in these patents.

Schwarz's process is a process for separating minerals from ores by buoyancy oil flotation, assisted, as the inventor believes, by the presence of air bubbles in the oily mass. It resembles, in many respects, the older known buoyancy flotation process, but the patentee uses an oil solid at normal temperatures and in that it differs from the older one. He believes he will be able to separate the concentrates either entrapped in the liquid when working at a higher temperature, or enclosed in a solid oil, when working at normal temperatures.

There is no resemblance whatever in the process of this patent with the process of the patent in suit, and the phenomena serving for effecting the concentration of minerals in the two inventions are absolutely different. The principle of the Schwarz process is well known and has been previously used in processes of entrapping
608 the mineral in such quantities of oil that the specific gravity of the combined mixture is less than water. This differentiated from the earlier process of this kind by the introduction of some minor variations and by the introduction of air, steam or gas, to increase the carrying power of the oil. The agitation froth phenomenon is absolutely new and nothing like it has been known, or used, before its discovery was revealed by the patent in suit.

30 Q. Please now give consideration to the two patents to Kirby, No. 809,959, issued January 16, 1906, for a Process of Separating Minerals, and No. 838,626, issued December 18, 1906, for a Separating Tank.

A. The patent 809,959 contains the description of a process and of an apparatus suitable for performing this process, whilst the other patent is only a patent for an apparatus which, in its main features, is identical with the apparatus described in 809,959. The process relates to the concentration of ores, and the inventor states that it may be practiced in many cases so as to separate metallic minerals which have to be treated in one way from other metallic minerals which have to be treated in another way, and as it is capable to separate the metallic mineral from the gangue, the inventor believes it to be a great step in advance of this art. The inventor says he has practised this process mostly only with Rossland ores (British Columbia), primarily for separating chalcopyrite from the other constituents, but he believes that his invention, or some of the novel steps, may be employed with advantage in the treatment of all ores.

609 The process consists in:

(1) Thoroughly agitating pulverized ore, sufficient water to make a flowing pulp and a solution of bitumen in a thin, distillable hydrocarbon, such as kerosene, so as to finely subdivide the bitumen solution into small globules and bring these globules into contact with substantially all the pulverized mineral particles, which will by preference adhere to them;

(2) Allowing the hydrocarbon coated particles to float to the surface of the mass, and assisting this process by gentle agitation of the mass, and by injection of gas, and by preferably also discharging into the mass fine streams of the solution of bitumen in kerosene. When the separation is completed, the floating concentrates are removed;

(3) Filtering the concentrates contained in the bitumen solution to free them, as far as possible, from the hydrocarbon liquid;

(4) Recovering the hydrocarbon which, after filtration, still adheres to the minerals, by distillation.

The inventor thinks that he was the first to use a gas in the flotation of the coated particles and that it was a radically new step, in which, however, he is mistaken, as other inventors had used this step before him; and this novelty he states makes it possible for the first time to use thin oils and hydrocarbons. The prior processes which employed heavy, thick, viscous oils, the inventor contends, will also be much assisted by the addition of this new step.

Of course, in spite of all the care exercised in the practice of
610 this process to keep the ore in large clots or masses, a great deal of it is floured or broken up in minute particles, which are trapped in the sands and lost. The introduction of air brings in a more powerful floating agency, which results in the recovery of this floured ore, together with numerous coated particles which could otherwise not be floated. This last step is, therefore, useful for the concentration of ore by processes depending on the use of oil lighter than water. Kerosene alone may be used with most ores to take out the sulphides provided that gas is used to cause the flotation of the kerosene coated particles. But it is the presence of the bitumen in the kerosene which gives the precise adhesive preference for separating the gold and chalcopyrite from the ore. Different forms of bitumen are mentioned, asphalt, bitumen produced by the distillation of petroleum to a semi-solid residuum, tar, pitch. The crushed ore is mixed with three or five times as much water by weight and a sufficient amount of the kerosene-bitumen solution is added. Excellent results are obtained by the use of hydrocarbon in the proportion of one-fourth to three-fourths by weight of the quantity of ore to be treated and the preference of gangue for water may be regulated by the addition of acid or other chemical. A distinct advantage for the use of a thin hydrocarbon is claimed by the inventor, as whatever quantity may adhere to the concentrates after the mechanical separation, that is after filtration, of the solution containing the minerals, such quantity may be recovered by
611 the simple process of distillation. With heavy viscous oils the proportion of the oil adhering to the concentrates after

filtration is lost. The injection of gas, preferably air, into the mass, which is the chief characteristic of the second process, assists in the flotation of the hydrocarbon coated particles, and renders it possible to finely subdivide the solution by the agitation, thereby greatly increasing the chance that all of the mineral particles which exhibit preferential adhesion for the solution shall be brought into contact with the solution. Some of the hydrocarbon coated particles will float to the surface without assistance, but a number of them will not be sufficiently buoyant and some of them and some globules of the mixture would be trapped in the sands. In order to recover this less buoyant material, together with the globules of the mixture, the mass which tends to settle is slowly lifted and turned over to liberate the coated particles and globules, and at the same time a gas, preferably air, is blown into the mass, by preference near the bottom thereof, and the air bubbles attach themselves to the coated particles and float them to the surface, and he attributes a further benefit to arise from the solution of the air in and to subsequent separation from water, the air thus separated attaching itself in minute globules to the coated particles. The floating concentrates are carried mainly at the lower surface of the hydrocarbon layer, which is in contact with the water, and the hydrocarbon is removed from these concentrates by filtration and the thin character
612 of the hydrocarbons allows the recovery of a large quantity by this process. The remainder which still adheres is removed by submitting the concentrates to which it adheres to distillation.

Kirby's process consists in the separation of minerals from ores:

(*a*) Partly by buoyancy flotation;

(*b*) Partly by lifting the aggregates of mineral in oil which are at the bottom, by air bubbles to the top, and removing the products of (*a*) and (*b*) together.

The quantities of oils with which the inventor claimed to obtain excellent results are specified as amounting to from 500 to 1500 pounds of oil per short ton of ore. The oil is recovered by filtration and distillation.

The apparatus consists of a mixing tank, a separating tank, a settling tank for concentrates, two filters, a settling box for receiving the liquid from the filters, a retort furnace for separating by distillation the last adhering hydrocarbon from the cencentrates, with the necessary additions for collecting the dust, for condensing the vapors of the hydrocarbon, and for receiving them after condensation. The mixing tank is provided with an agitator and has on the top a pipe through which the hydrocarbon is admitted. The mixed pulp flows out at the bottom. The agitator has certain characteristics, but as they are repeated in the agitator contained in the separation tank, they shall be detailed there. The agitation in the mixing tank is to be thorough, which is stated in the body of the specification and also indicated in the sketch, Figure 1. The
613 vertical shaft with which the separating tank is provided is rotated by a gear at its upper end. The head of this shaft above the driving gear passes through an air and oil box, which re-

mains stationary whilst the shaft revolves, and it is supplied by a pipe carrying the hydrocarbon and by a pipe for air admission. The box rests on the rotating shoulder of the shaft and is fastened to a tight joint by a collar and a lock nut. A small hydrocarbon pipe is conducted through the hollow shaft, the upper end of which is firmly inserted within the upper extension of the shaft. This central pipe conveys the hydrocarbon to the separating tank. The air enters through the air pipe into an annular chamber and passes through its open bottom through a set of apertures into the interior of the shaft. The step bearing is supported on a pedestal provided with a wooden block, which supports the moving wearing plate of the shaft. Lubricating water is introduced through a pipe and leaves through a side groove. The sides of the shaft are carried down below the bearing so as to leave an annular space between them and the pedestal. This annular space is intended to constitute an air bell designed to assist the lubricating water in excluding sand from the bearing, and the air supply is maintained in it by a slight stress of air which enters beneath the bell through a pipe. The air current to be used to assist in the flotation of the kerosene coated aggregates passes down through the shaft, then through side channels
614 into the two hollow arms of the agitator, and from there through pipes which are carried downward into the mixture of pulp and oil. The hydrocarbon liquid is delivered through small pipes paralleled with the hollow arms of the agitator and it emerges from downward outlets into the mixture. Each hollow and cylindrical arm of the agitator is provided with scraping plates and an inclined lifting plow, which latter is fixed to the extreme end of the arm. It is arranged in such a manner as to force the circulation upward at this point. The rotary movement of the charge, when the agitator is in motion, leads the floating hydrocarbon liquid, air bubbles and concentrates, which mixture the patentee terms "scum," against a skimming bar, which is arranged in such manner so as to arrest and deflect this floating layer and cause it to pass into the second and washing chamber, which is a separate arrangement contained in the separating tank. The edge of this box outside of the skimming bar is submerged sufficiently to allow the floating material to pass over it, whilst the remaining part of the said edge is raised above the liquid so as to retain everything passing into it. The water within the separating tank is, owing to agitation, and to the rising air bubbles, not clear, but turbid and muddied with slimes of fine particles of the gangue, which do not settle rapidly enough to get out of the way. The floating concentrates are carried mainly at the lower surface of the hydrocarbon layer, where it is in contact with the water, and the launder, which is provided to permit
615 the floating particles to pass out, must be set low enough to clear them, and must, therefore, allow a portion of the water to pass out with the floating hydrocarbon. This water contains gangue slimes, which would, if allowed to remain, finally contaminate the concentrates, and a settling and washing chamber is provided within the tank to lessen or to prevent this evil, and the bottom of this box is divided into compartments by submerged partitions,

each compartment terminating in a hopper shaped bottom with discharge openings through which the separated slimes pass back into the tank. A projecting shield prevents the air bubbles from entering the hoppers of the washing chamber and distributing the settling of the slimes. The floating material drops most of the slimes carried along with the water in this settling chamber. Before the hydrocarbon liquid passes over the gate, it passes over a stream of clean water and then into a launder which terminates in the settling tank. Instead of first going to a settling tank, it might go straight to a filter, but the patentee advises the use of a settling tank in order to get rid of the main body of water, and, therefore, of the bulk of liquid to be submitted to the filtering operation. The settling tank is a cylindrical vessel with a hopper-shaped bottom, within which a cylinder is suspended reaching half way down. The stream of the concentrates enters the center cylinder, within which the water and the hydrocarbons separate, the former sinking, whilst the latter, with the accompanying concentrates and air bubbles, floats
616 in a layer. There is a stirrer provided within the cylinder, the arms of which revolve gently within this layer so as to break up and discharge air bubbles and assist the separation. Most of the concentrates hang on near the contact between the hydrocarbon and the water and as this contact surface becomes overloaded with concentrates, some of them sink to the bottom of the tank. The excess of hydrocarbon accompanied by some of the concentrates flows into a filtering apparatus. The concentrates, which form in the bottom of the tank, accompanied by the hydrocarbon which adheres to them, are drawn off, in a thick condition into a filter apparatus, where the concentrates are separated by filtration from the hydrocarbons. The filtration of the hydrocarbon layer first described and of the concentrates which have fallen to the bottom of the settling tank may be carried out in one or two filters. As the first mentioned mixture of hydrocarbon and concentrates consists mainly of hydrocarbon and concentrates, it might be advantageously separated in one filtering apparatus, whilst the concentrates which have sunk to the bottom and with which a large quantity of water is mixed, might be treated in another filtering apparatus. A mixture of hydrocarbons and concentrates can be easier separated by filtration than a mixture of hydrocarbon, water and concentrates. There are some details given which are not essential to the understanding of the apparatus. Furthermore, a plant is described consisting of a furnace and a condensing arrangement in which
617 the last remnants of hydrocarbon remaining after filtration are removed from the concentrates by distillation.

The apparatus is worked in the following manner: the agitation in the first tank must be thorough. It serves to oil the pulp. The agitation in the separating tank must be gentle to accomplish the purpose for which it is used, namely, allowing the air bubbles to attach themselves to oiled aggregates of minerals. It is specified that it has to be gentle.

Adjourned to Wednesday, October 23, 1912, at 10:30 in the forenoon, at the same place.

New York, October 23, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 30 Q. continued: Patent No. 838,626 describes and claims the same apparatus with the exception of a few unimportant alterations. The skimming device is slightly altered, but not in principle.

I have described the apparatus more in detail because it takes up so much space in the first patent and is the exclusive invention of the second patent. Only a few points are of importance according to the inventor.

618 (1) The introduction of air and the necessity of gentle agitation, that is, the gentle turning over of the mass in the separating tank into which the air is introduced.

(2) The additional novelty of saving the hydrocarbon liquid by distillation.

(3) The possibility of the use of a thin hydrocarbon for the purpose of the recovery of the mineral.

The experience which I have gained from experiments makes me doubt whether the assertion made under (3) is a fact. In my view, no thin oils can be used with advantage, and the patentee himself describes that the minerals collect on the bottom of the layer of the thin oil which is near the water surface. That involves that the minerals continuously break through by sheer force of their weight and return to the bottom of the water, which renders of little use all the processes in which gas is generated or introduced through pipes for the purpose of lifting oily aggregates.

The fact stated under (1) is of importance and correct. The attempts to attach air bubbles to aggregates of oiled minerals can only succeed by gentle turning over of the mixture of sand and oiled particles. Thorough agitation would make it absolutely impossible.

The process of separation of minerals revealed in this patent is a process of buoyancy oil flotation assisted by the inclusion in the oil of air bubbles. Dr. Byrnes, on page 150 of Defendant's Rec-

619 ord, gives an extract of the facts contained in the specification, and on page 154 states what in his view are the points shown in the two Kirby patents. I think there ought to be added to (2), "excellent results" being obtained by using 500 to 1,500 lbs. of oil to 2,000 lbs. of ore.

As to (5), the tank A is described as being preferably cylindrical and in this it differs, according to the evidence of defendant's plants, from defendant's tanks, which are square. The effect of agitating in a round tank is different from the effect of agitating in a square tank, even at the same speed. It is much less thorough. But I object to the comparison of a process of incorporating 500 to 1,500 lbs. of oil with a ton of ore, within a process for incorporating two lbs. of oil with a ton of ore. These two processes do not allow of comparison.

What would be thorough agitation in the first case might be highly inefficient in the second case. The whole of the paragraph is not clear to me, and I cannot understand the remarks (Defendant's Record, page 154):

"(5) The thorough mechanical agitation of the ore-pulp, acidulated, and the oil, by a rapidly rotating shaft having radial agitating blades, which type of agitator, employed by the defendant in this suit, is found to be a most efficient one for intermingling atmospheric air with the mass and thoroughly aerating the oiled mineral to produce a floating froth of concentrates."

620 If Dr. Byrnes means only that the apparatus called the mixing tank A of Kirby's patent, which is by preference cylindrical, is as efficient as the square box at the same speed, I have already disagreed with this proposition. But if he further wants to imply that Kirby produced a froth in his process, then I say that is not so, and it is clearly described in the document that it is not so (Spec. No. 809,959, page 3, lines 55-58):

"The floating concentrates are carried mainly at the lower surface of the hydrocarbon layer, where it is in contact with the water."

And this passage also contradicts the allegation expressed in (6) that the concentrates form a froth. Dr. Byrnes calls any liquid in which some air bubbles are enclosed a froth. My definition, and I believe it is a true one, of a froth is, a collection of bubbles surrounded by liquid films appearing on the surface of a liquid. Dr. Byrnes describes an experiment which again proves that he cannot put himself into the condition of the knowledge which existed at the time of Kirby's application for Letters Patent. He improves the process by using all the knowledge which he has got to-day. If a patent or publication is meant to serve as an anticipation to a later patent, it ought to reveal the invention, and in carrying out the process for that purpose, it ought to be carried out as described. Kirby's patent directs you to agitate thoroughly to effect through oiling of the

621 minerals, then to agitate gently and to introduce a current of air through pipes into the bottom of the agitating vessel to carry those aggregates of oiled mineral which had been left at the bottom to the surface of the water in order to unite them with the layer of hydrocarbon which had collected there after the first agitation was stopped. Dr. Byrnes uses a "Hyde slide machine" for his experiments and says, by using this machine, "I was able to oil and aerate without any injection of streams of air to float the particles entangled in the tailings." The directions of the patent are: oil the particles thoroughly and agitate them in an apparatus different from the slide machine and allow the mixture to settle, when a layer of hydrocarbon will appear at the surface of the water and a number of aggregates of oiled particles will be with the sands at the bottom of the water; then agitate gently, that is, turn the sand with oiled particles slowly over (Spec., page 2, lines 61-63 of 809,959):

"The mass which tends to settle is slowly lifted and turned over to liberate the coated particles and the globules, and at the same time a gas, preferably air, is blown into the mass preferably near the bottom thereof."

I say that Dr. Byrnes did not carry out Kirby's invention at all in this experiment and there is no similarity between Dr. Byrnes' process and the process and apparatus revealed in the two Kirby pat-
622 ents. Dr. Byrnes says, he also roughly imitated the operation of blowing air carried out by Kirby by the use of a single tube pushed downward into the tailings at the bottom and moved about therein, but he does not say what benefit he got from it. Apparently none, because he removed the first froth which, according to my experience, must have been a layer of hydrocarbon liquid with some air bubbles enclosed, and then continued agitation and aeration (he does not say how often). The tailings were left comparatively light in color; that is, they consisted, according to his statement, largely of gangue.

I made an experiment and used the same apparatus, namely, the slide machine, which had been used by Dr. Byrnes. 500 grams of defendant's ore, which had been crushed in my presence to 80 mesh and which contained 18.1% of zinc, 1,600 cc. of water and 1 cc. of concentrated sulphuric acid, were made in a good pulp, then 125 parts of a solution containing in 105 parts 100 parts of kerosene and 5% of Trinidad asphalt were added, and the mixture, having a temperature of 35° Centigrade, was thoroughly agitated for five minutes. After stopping the agitation, a layer of oil settled on the surface of the water, which layer of oil enclosed minerals, some bubbles of air and some water. The mass of gangue and pasty minerals which was at the bottom of the water was then gently agitated, and gas injected into it through a pipe which was coiled at the bottom and
623 perforated in the coiled part. The result of this operation was that the layer of oil and mineral which was on the surface of the water was disturbed in such a manner that most of the oiled minerals sank to the bottom of the apparatus, and only a very small part of it was left on the surface of the water mixed with very few air bubbles. As this operation proved so unsuccessful, another 250 grams of kerosene-asphalt solution was added in a stream to the mixture which was being gently agitated at the same time. The result was that oil was both on the surface of the water and at the bottom. Therefore, the thorough agitation was repeated for one minute and more oil came to the surface of the water, but on blowing air in whilst the mass was being gently agitated at the bottom, part of the oil again sank. The layer of oil on the surface was taken off and the gentle agitation of the residue was so often repeated as oil would come to the surface, and each time the oil which had risen was collected. The result of this experiment was the recovery of 39% of the zinc contained in the ore.

The Kirby patents and the process revealed therein have nothing in common with the patent in suit and the process revealed therein. The Kirby patents and process rely on the separation of the minerals from ores by buoyancy flotation of the oil and mineral, assisted by the enclosure within the oil of air bubbles. It is apparent from the documents that it is not intended as something different, and the physical phenomenon involved is well known and had

624 been used for that purpose before. The process of the patent in suit depends on a new and entirely different phenomenon, which is neither revealed in Kirby's specifications nor in any of the other documents which form part of defendant's case as to anticipation.

I have stated that the agitator in the mixing tank has certain characteristics, which are repeated in the agitator contained in the separating tank. These characteristics are that the arms are cylindrical and each is provided with scraping plates and an inclined lifting plow. The oil and air feed provisions are not contained in the agitator of the mixing tank. The oil is fed into the mixing tank by a separate pipe which goes in at the top of the tank. The patentee further states that the separating tank can be used for both the mixing of the oil with the pulp and for the separation of the oiled particles from the gangue. He says:

"It is merely necessary to rotate the agitating mechanism rapidly while mixing and to rotate it slowly while the separation is being made" (Spec. 809,959, page 3, lines 121-124).

It is self-evident that during the oiling of the pulp, the air supply is cut off.

By Mr. Williams: A certified copy of the Italian patent to Alcide Froment, No. 63,723, the specification of which bears the date of May 20, 1902, is now offered in evidence and marked "Complainants' Exhibit, Froment Italian Patent."

625 31 Q. Have you read the Froment Italian patent just offered in evidence, and do you understand the same, and have you made and will you produce a translation thereof into English of all parts of the document except the formal certifying parts?

A. I have done so and I understand the document and I now produce a correct translation thereof such as is asked for. I have been familiar with the French language for very many years.

By Mr. Williams: The translation produced by the witness is offered in evidence and marked "Complainants' Exhibit, Translation of Froment Italian Patent."

32 Q. Please now give consideration to Froment British patent No. 12,778, of 1902 (date of application June 4, 1902), sealed August 18, 1903, and the Froment Italian patent No. 63,723, the specification of which is dated May 20, 1902.

It is stipulated that British patent No. 12,778 of 1902 was sealed August 18, 1903.

A. The British patent No. 12,778 contains a provisional and a complete specification. As the provisional specification is identical with the complete specification, with the exception that there is no claim contained therein, I will only take the complete specification into consideration.

The invention disclosed in the Italian patent and in the
626 British patent is identically the same in both documents. There are slight differences, to which I will call attention when I am coming to them.

The invention relates to the concentration of metalliferous ores and earths for the recovery therefrom of the metals or metallic compounds, and the patentee states that it is a modification of the known oil process for the concentration of ores, or, as he says,

"a modification of what is known as the oil process of ore concentration."

The only process known as the oil process of ore concentration at that time was the Elmore oil buoyancy flotation process. Further, it is in evidence that this Elmore process was tried at the Traversella Mine in Italy, where Mr. Froment was the engineer (Complainants' Record, page 308), as testified to by Mr. Ballantyne. I am sure, therefore, that this statement, which is in the forefront of the specification, can only refer to the Elmore buoyancy oil flotation process.

The inventor then continues and describes four phenomena which serve as a basis of the process which forms the substance of his invention:

"(1) When natural sulphides reduced to powder are moistened by a fatty substance, they have a tendency to unite in spherules and to float upon the surface of the water." This means that the ore must be mixed with a substantial quantity of oil, as such a tendency only results if ore is mixed with sufficient oil to substantially reduce its specific gravity.

627 "(2) This tendency is simply retarded by the specific weight and opposed by the gangue which imprisons the moistened sulphides in its pulverulent mass." From this statement it is clear that Froment does not contemplate using the large quantities of oil which were used in the process well known to him, namely, Elmore's process, because he suggests that the specific weight of the mixture of minerals and oil is larger than water. But that is not the only reason which he gives. The mixture of mineral and oil which he had produced was imprisoned by the gangue and the gangue prevented or opposed the rising of the oil-moistened sulphide. There can be no doubt that both gangue and the oiled sulphides were at the bottom of the liquid.

"(3) If a gas of any kind is liberated in this mass, the bubbles of the gas become covered with an envelope of sulphides and thus rise readily to the surface of the liquid where they form a kind of metallic magma." The inventor found that, when a gas is generated in this mass, as he says in his Italian patent, the gas envelope will attach to itself the oiled minerals, rise with them to the surface of the liquid and form a magma, which is a pasty mass and which consists of a substantial quantity of oil carrying minerals and having gas bubbles enclosed in the oil.

Adjourned to Thursday, October 24, 1912, at 10:30 in the forenoon, at the same place.

628 New York, October 24, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Direct examination continued:

Answer to 32 Q. continued:

"(4) The formation of these metallic spherules is singularly active if the gas is in a nascent state." It is not quite easy to understand the meaning of the patentee, but I will give my interpretation of it. In paragraph (1) Froment says that the sulphides have a tendency to unite in spherules when they are moistened by a fatty substance. This would mean that with a sufficiency of oil and opportunity of coming together, spherules or little globes or blobs of oil containing sulphides would be formed. These spherules or blobs would, of course, have no gas in them, but oil.

In paragraph (4) Froment says that the "formation of these metallic spherules is singularly active if the gas is in a nascent state." I say with reference to this paragraph, it is reasonable to assume that Froment was describing the formation of minute gas bubbles and the flowing of the mineral embedded oil about these minute bubbles. The spherules of paragraph (4) differ in this respect from the spherules of paragraph (1). In the latter case we have got little spheres of oil containing sulphides. In the former case we have little spheres of oil containing sulphides but
629 each having a small bubble of gas in its center. In one case the spherule means a solid little sphere of oil; in the other case, the spherule is a hollow little sphere of oil. The mineral particles entrapped in the oil would, of course, be carried by the gas, and when these bubbles, coated with oil and mineral, rise by their buoyancy, they will go to the upper surface and in this upper surface the liquid oil on the several bubbles would be united in a paste of oil and minerals having air bubbles in it. To express it in a different way, the identity of the spherules would be lost. We would have on the surface, as Froment says, "a magma" of oil separated from the rest of the liquid, thickened by minerals, and containing gas bubbles throughout its oily mass which would lighten this magma and increase its buoyancy. I have found in my experiments that this oily mass or magma, floating at the top of the liquid, does not contain spherules or little spheres, but that it is a mass of oil in which the identity of the spherules has been lost.

From these statements contained in the fourth paragraph, of which I have given my interpretation, the process intended to be used is quite clear. Froment mixes a pulp, either containing a carbonate or to which one had been added, by agitation with quantities of oil which are suitable for his purpose, namely, that the oil-moistened minerals are contained at the bottom of the vessel intermingled with the gangue. It is clear to me, quite independent from the guidance which I find perfectly definite in the specification, that

630 he used large quantities of oil, very large, if we compare them with the quantities used by the inventors following him, for instance, Cattermole. Froment's process is a modification of the process which is known as the oil process of ore concentration, which, as I have said, was Elmore's process. Froment endeavored to reduce the large quantities of oil which are necessary for Elmore's process, and to effect an economy. If he did make experiments systematically, he would find that his first efforts would result in the production of a layer of oil on the top of the water with minerals therein and of some oil with minerals embedded in the gangue. He would finally arrive at a point where all the oil plus minerals was embedded in the gangue only. He would notice that they contained such a large quantity of oil that there was a tendency in them to flow together and to form spherules or globules, but these globules would not rise because they are too heavy. Then he evolved the idea of trying to lift them (the oiled minerals) by means of a gas and he found that when he generated the gas in the mixture, produced it in statu nascendi or nascent condition, he produced spherules which rose with ease to the top, united there and formed a magma.

After he had mixed his oil and ore, which was resulting in the dissemination of the oiled minerals through the gangue which contained a carbonate, he would add the acid to generate his gas, carbonic acid, and the gas would first form the spherules and these would rise to the surface and form the magma. He would
631 collect the magma, separate the oil from it, as is later described in Froment's patent. That is the process which this fourth paragraph revealed to me.

He then describes, not an example of how to carry out ore concentration as a manufacture, if I may use that term, but a test tube test, in which any one could quickly see the result of his discovery. He says:

"Thus for example, if in a test tube there is placed say ten grammes of sulphuretted copper ore with its gangue, a gram of limestone, the whole reduced to powder, and if there is added thereto thirty grammes of water, a few drops of sulphuric acid and a thin layer of ordinary oil, and the mixture then agitated for a brief space, the whole of the copperpyrite will instantly rise to the top of the liquid. The metallic spherules, pressed one against the other, will become grouped in a magma clearly separated from the rest of the liquid. If the limestone is in excess, or readily attackable, the rapidity of the separation is so great that the copperpyrite is forcibly projected outside the vessel. There is therefore a proportion to be sought for a given ore and limestone."

I will call attention at once to the fact that the agitation which is described here as being an agitation for a brief space, is described in the Italian patent as being an agitation for a second.

It is not clear to me from the description given what the
632 experiment means. I tried to perform it by following verbally the instructions, but the result was such as is very frankly stated by the inventor, namely, that the contents of the test tube found another abode on the walls of the laboratory. I cannot

understand the sentence finishing the before-quoted paragraph. The proportion between ore and limestone cannot prevent the ejection of the contents of the test tube if there is a sudden generation of gas, and if there is an agitation for a brief space, that is, one second, as definitely stated in the Italian patent, there must always follow the destruction in the way I explained before. The Italian specification precedes the English one by a short time and the English is clearly a translation of the Italian document with such slight alterations as a translator who was a British patent agent, would make. There are some other mistakes in the British document, which cloud the true meaning of the original to which I shall have to call attention later.

Adjourned to Friday, October 25, 1912, at 10:30 in the forenoon, at the same place.

633 New York, October 25, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 32 Q. continued: I have stated before that the first experiment produced according to the test tube example, page 2, lines 33-42, was a failure. The whole contents of the test tube were violently scattered through the laboratory. I must add that if precautions are taken, it is possible to perform the experiment and see the oily magma which appears on the top of the aqueous surface. The magma, which was an oily layer containing minerals and carbonic acid gases, had separated from the rest of the liquid. A superficial observation would perhaps give the impression that it had the appearance of a froth, but it is not a froth. It is only a layer of oil in which minerals and carbonic acid bubbles are embedded. In some respects I had difficulties to understand this example. I gather from the description preceding the example that part of Froment's invention, and it is an important part, relies on the generation of a gas in the nascent state within the mixture of the moistened sulphides and gangue. The addition of the ten per cent. of calcite (one gram) can only be for the purpose of serving as a source for the nascent carbonic acid gas. There can be no other use for it. Yet the patentee says in his example, add

634 "a few drops of sulphuric acid."

Perhaps it would be useful to explain the function of this sulphuric acid. Calcium carbonate is a combination of calcium oxide and carbonic acid. In order to release the carbonic acid from the calcium carbonate, which chemists call the calcium salt of carbonic acid, it is necessary to act on it with a stronger acid which expels the carbonic acid and takes its place. Chemistry teaches us that this action is produced by using definite quantities of both calcite and sulphuric acid and that to get all the carbonic acid from one gram of calcite, one gram of concentrated sulphuric acid is to be

used. It is clear that the calcite is present only as a source of carbonic acid, yet he uses for the decomposition of one gram only a few drops of sulphuric acid, which must be less than one gram. The quantity of oil to be used in the test tube experiment is also not well defined. He only defines the least quantity which can be used and does not give us the upper limit. The least quantity is easily determined and I find it to be 12½% of oil in relation to the ore, but he doesn't say, use the thinnest layer of oil which can cover the surface of the water, but a thin layer, which might be substantially larger than the 12½% which I found was the quantity which would form the thinnest layer on the water surface contained in the test tube suitable for this experiment. 80 cc. of water would fill the test tube and its diameter was about .9 of an inch. As I said before, certain points can be gathered from this test tube experiment.

635 On the other hand, no satisfactory details of the process are given and to infer it from the description is rather difficult. The next paragraph states the result. The mechanically conveyed gangue falls down and the sulphides remain in a state of almost complete purity. Then follows a remarkable sentence:

"Such is the principle."

The Italian document did not give me any assistance in explaining what he meant by this. I have understood the preceding part in which he laid down, in four paragraphs, the principles on which his invention is based, as stating the principle of his invention.

The next sentence seems to me to emphasize the short duration of the preceding experiment. The English patent says,

"agitated for a brief space,"

which defined by the *Italian* specification, of which the English document is a translation, means

"agitated for a second,"

and must be advice to generate the carbonic acid as quickly as possible; at least, I cannot draw any other conclusions from it.

The word "thus" beginning the last paragraph on page 2, before example 1, is an unsatisfactory translation of the French. It ought to be "accordingly," as in my translation.

636 Example 1 is so brief and devoid of information that I did not get any assistance from its study and I feel that I should quote it:

"Example 1.

A cuprous ore containing 12% of copperpyrite, 15% of iron pyrite, 20% of carbonate of iron, 16% of dolomite and calcite and 37% of various gangues have been submitted to my said process. It should be stated that this ore could not be enriched economically by any known means.

Only a few seconds were necessary for completely separating the sulphide of copper from the rest of the gangue in which no single trace of copper could be discovered by analysis."

Is the process referred to in this example the test tube illustration, which he calls his "principle," or what is it? It is not revealed in the description, and the brevity of his description is, in this case, not resulting in concise information. As a matter of fact, the only information conveyed by the description is that only a few seconds are necessary for complete separation. If any conclusion is to be drawn from this example, it must be that it is a repetition of the first test tube example, as only a few seconds were necessary after the one second agitation to obtain the separation of the sulphide of copper "from the rest of the gangue," which surely should have been, from the rest of the ore.

637 Example 2 is even shorter than example 1. I will quote it:

"Example 2.

An ore having 10% of lead and unmarketable with such a proportion has been treated in the same manner and with the same success.

It is certain, from the description of the two examples, that they are not examples of the carrying out of the process, but that they are examples of ores which Froment had shaken with oil, calcite, water and acid for a second in the test tube. At the end of the example, the patentee states:

"There are several operations which are distinct but which are connected in carrying the process into practice; the formation of the spherules and their separation from the gangue, then separation of the product of the concentration from the oil and recovery of this latter for readmission to the cycle of operations. The products of the concentration form cakes."

In my translation of the Italian patent, I corrected this to read as follows:

"There are several distinct but connected operations in the practical working of the process; the formation of the spherules and their separation from the gangue, then separation of the concen-

638 trate and the oil and recovery of this latter for re-entrance into the circuit of operations. The products of the concentration form oil cakes."

This addition is again very devoid of information. It does not assist in carrying us farther than the test tube example. It doesn't state facts which would be of assistance in carrying this beyond the test tube. One may infer from the words:

"the formation of the spherules and their separation from the gangue,"

that the patentee contemplates first the production of oiled minerals heavier than water and buried in the gangue, but he does not say how he produces them; that he contemplates the formation of spherules from these oiled minerals and their separation from the gangue by generating a gas in the mixture of the oiled minerals with the gangue, but he does not describe such an operation and the conclusions can only be arrived at by inference. But one definite

fact is clear, namely, that he uses substantial quantities of oil, which he recovers, and clearly by one of the old and well known processes used for such operations, either by squeezing the oil out by means of a filter press or by centrifugal force, etc. That follows clearly from the last sentence:

"The products of the concentration form cakes,"

639 or, as it is stated more correctly in the Italian document from which apparently the translation was made,

"The products of the concentration form oil cakes."

The latter expression is more correct, as it is impossible by the use of filter presses and similar apparatus to squeeze out all the oil from a mass of minerals and oil. At the best, from 8 to 10 per cent. will be left with the minerals.

The claim which reads—

"The herein described process for the concentration of metalliferous ores and earths which consists in mixing the finely powdered ore or earth with water, adding a suitable oil and then liberating a gas in the mixture substantially as described and for the purpose specified"—

is very obvious. If it is meant to contain the process which is described, it is true, only as a test tube example, then it does not do so. The only construction which I can put on it, if I may offer an opinion on a subject the decision of which rests with the Court, is as follows: Make a pulp, mix a suitable oil with it and liberate a gas in the mixture. I fail to find such a process in the body of the specification. No doubt the principles on which the invention is based, and which are contained in paragraphs 1, 2, 3 and 4 of page 2, might be described by the language of the claim. But the only process
640 which is described is quite outside of it and I fail to find the process in the language of the claim.

The impression which is conveyed to me by Froment's patent may be summarized very shortly. The intention of the inventor was to modify the process of ore concentration known as the oil process of ore concentration. It is clear to me that he wanted to do this by making an economy in the use of oil, which is very large in the only oil concentration process which had been practically tried. The principles which guided him I can also understand, but when we approach what ought to have been the full description of a working process and of the means by which it could be accomplished, they are not disclosed in the document. The whole invention is based on the test tube experiment, of which he says that, if the mixture is not right, or, to put it in his own language, if there is an excess of limestone, the rapidity of the reaction is so great that the valuable material is ejected from the vessel. Only one fact stands out clearly. He must have used substantial quantities of oil for his test tube example, which I have proved by the actual estimation of the smallest quantity which would be in accordance with his description, and

which is proved as well by the fact that he describes the recovery of it. Having had the practical experience of the Elmore process, he was, of course, conversant with the mode of recovery therein practised, and he would know the limits for which it was prac-
641 ticable. The invention of Froment consists in an idea not yet realized, but which might have contained a germ, from which a process capable of practical working might have been derived, although it is difficult to see how it could have been a practical success.

By Mr. Scott: Objection is made to the following passage forming part of the answer to the preceding question:

"The Italian specification precedes the English one by a short time and the English is clearly a translation of the Italian document, with such slight alterations as a translator, who was a British patent agent, would make. There are some other mistakes in the British document, which cloud the true meaning of the original to which I shall have to call attention later."

This objection is based upon the ground that the witness's statement that the Froment English specification is a translation of the Italian specification, with such alterations as a translator would make, is secondary and incompetent as being merely an inference on the part of the witness regarding a matter of which he has not shown and does not claim to have any direct knowledge. The witness's reference to mistakes in the British document is likewise ob-
642 jected to as secondary and incompetent, as is also his reference to the Italian patent as "the original," and his reference to the true meaning of the original being clouded. The British patent was duly applied for by and on behalf of the inventor, as shown by the patent itself and by the record in this suit, and was duly granted. Its legal effect as a patent and as a publication must be derived from the document itself. No evidence has been offered to the effect that Froment intended that his British patent should be the same as his Italian patent, and such evidence, if offered, would be incompetent to alter the effect of the British patent as a patent and as a publication.

The foregoing objection is made not only to the passage quoted, but to all use by the witness of the Italian patent as a means of modifying the meaning of the British patent.

By Mr. Williams: It is submitted that the statement of the witness objected to is a proper expression of opinion arising from the study of the two documents, their succession in dates, and the fact that the British patent was applied for by the British patent agent, Henry Harris Lake, as a communication from the inventor, instead of by the inventor in person.

33 Q. Please now give consideration to "Complainants' Ex-
643 hibit, Froment Description," "Complainants' Exhibit, Froment Plan," "Complainants' Exhibit, Froment Drawing A" and "Complainants' Exhibit, Translation of Froment Description and Descriptive Matter in Froment Drawings."

A. I gather from the evidence that the description and the different drawings came into the hands of the complainants about a year and a half after the filing of the British provisonal specification, that means, after the application for British Letters Patent, and it should contain the experience of Froment, or the development of the thoughts of Froment, during the interval.

In order to understand the plant which is revealed in the drawings, I will first deal with that part of the written description which is marked "Instructions." Ore to be perfectly disintegrated without being rendered impalpable should be crushed in two operations. The first crushing should be done in a Ball crusher mill or in a Griffin mill or any other mill, in such manner that it should pass through sieve No. 15. The second crushing should be of such kind that the ore will pass through a sieve of about 120, and a Huntington mill or a stamp mill, etc., should be used. The output is much greater by the dry process than by the wet process, but there is also a greater proportion of impalpable particles. The slimes which are too fine to be treated, and which one has not been able to treat hitherto by any method, have to be eliminated by submitting the ore to two or three spitzkasten. It is from there introduced with a little water into the mixing apparatus for which 200 to 300 kilos constitute a
644 charge. About 1% of carbonate of lime, the maximum in difficult cases being 2%, and about 1 to 1½ per cent. of mineral engine oil are added, and the mixture is agitated for about ten minutes, the chief point being that all the sulphide particles should be well oiled. The instructions continue that if the ore contains more than 5% of metallic matter, such as copper or lead, it will be necessary to add a little more oil. Generally, however, one may assume that the following quantities may suffice:

"1% of oil for ore containing up to 5% of metals; 1½% of oil for ore containing up to 10% of metals; 2% of oil for ore containing up to 15% of metals."

The instructions then contain some observations about concentration of ores, and which ores were usually concentrated in the Latin countries. Copper ores, with 15% of copper, are considered very rich there and are treated as such. With lead ores, the concentration is continued until the ore contains 60% of lead. For a lead ore containing 20% of lead, 2% of oil will be necessary; for one with 30% of lead, 2½%; with 40% of lead, 3%; with 50% of lead, 3½%. As to the proportion of carbonate of lime, the instructions say:

"It seems reasonable to assume that the proportion of the carbonate of lime follows practically the same rule, for a richer ore will require more gas than a poorer one."

645 I have quoted the above from the translation in evidence. My own translation from the French original would be as follows:

"It is logical to assume that the carbonate of lime follows nearly in the same proportions, because a richer ore requires more gas than a poorer one."

The cost is, therefore, in proportion to the richness of the ore. The process of recovery is more suitable for a poor ore than for a

rich one. It would be perfect, for instance, to treat sterile ore or half mixed ore or residues from the ordinary washing apparatus, especially when difficult ores have been treated by the washing apparatus.

The instructions return after this discussion to the process. The oiled ore is discharged from the mixing apparatus, which has to be continually kept agitated during this operation, and then into a vessel provided with a coil. The agitator, with which the latter is provided, is then started at the rate of 10 to 12 revolutions per minute, so that the ore does not settle at the bottom in too compact a mass. A solution of sulphuric acid (containing 35% of pure sulphuric acid) is introduced into this mass through a leaden pipe. The vat should be filled with water to the level of the overflow. The lead pipe, which is provided for introducing the acid, has two branches, one of which is provided with a valve and it can be used for the admission of steam or water as desired. The quantity of sulphuric acid varies with
646 the quantity of carbonate of lime, that is, it is in proportion to the latter, and for 1% of carbonate of lime 1% of concentrated acid, that is, about 3% of the dilute acid which Froment mentions as suitable, should be used. As soon as the acid begins to mix with the ore, the reaction, that is, the generation of carbonic acid, will begin and the gas bubbles will carry the greased sulphides to the surface. The concentrates are skimmed off or pushed into an overflow. The small proportion which again sinks to the bottom and is mixed with the gangue, can be, from the moment that the sulphide particles have been well oiled, easily separated on the purifying screen on which they will be subsequently treated. When no more gas bubbles pulling sulphides rise to the surface of the liquid, the gangue, containing a small quantity of sulphides which have remained in it, is gradually poured to the purifying screen. This screen should be worked by short jolts, about 200 per minute, and these jolts should be sudden and without duration. It has been found difficult to produce such repeated jolts by means of the eccentric of the experimental screen, which is easily understood. One must find it out by experience. On a manufacturing scale, the shaking of the screen is effected by a very simple apparatus, of which a sketch is given on a separate sheet. Owing to the jolts, the mixture of gangue and oiled minerals spreads uniformly in a thin layer on the screen. The oiled sulphide particles rise to the top, thus being able to reach the end of the
647 screen, whilst the gangue passes through the heavy portion. The water which passes through the overflow of the screen enters into a filter case and any of the sulphide particles which might swim on it are retained therein. The concentrates might then be submitted to treatement in a hydraulic press or in a filter press, by which the recovery of a very large proportion of the soil used may be achieved.

Adjourned o Monday, October 28, 1912, at 10.30 in the forenoon, at the same place.

New York, October 28, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 33 Q continued: The apparatus as explained by the drawings and in the description, consists of a cylindrical centrifugal mixing device provided on the top with a hopper or chute for the introduction of the ore, and an oil pipe which is not shown in the drawing. The centrifugal mixing device contains two stirrers working in opposite directions, which are driven from a shaft provided with a driving wheel and make about 300 revolutions per minute.

The contents of the mixing vessel are discharged through a
648 pipe at the bottom of the vessel into two receivers, and from there into a vat with a coil, which is provided with a rake, a coil at the bottom having two branches at the end which is outside the vessel, a discharge pipe for the tailings at the bottom of the vessel, and a launder at the top. The purifying screen is fixed on a case in which there is a water pipe with a valve inserted so that the case can always be kept full of water. The moving of the screen is effected by a pulley and a shaft, and the screen itself, which is made of aluminum, is mounted on wood. The case in which the water is contained is provided at the end on the top with a pipe for discharging any light sulphides which might then fall into the filter. At the bottom of the case there are discharge holes for the residues, which are for dropping the residue into spitzkasten if it is desired to classify the residue. The screen is supported by wooden supports. The final part of the plant consists of a filter case, which contains four canvas filters, stretched on both sides over wooden frames and the space between the two canvas sheets is filled with charcoal powder. There is further an emergency discharge pipe provided.

There is further a sheet marked "A," which illustrates the way in which provision is made for the jolting of the screen. This drawing is clear enough to speak for itself. It is to be noted from this drawing that the shaking screen is wholly immersed in water, as it is entirely below the liquid level dertemined by the overflow launder.

649 The leaden coil which is contained in the second vessel is perforated, the perforations being at the bottom of the coil. I mentioned that the coil ended at the outside and in two branches; an ordinary T, one branch of which is for the admission of sulphuric acid, the other for the admission of steam or hot water. There is no necessity for this T pipe except for cold countries, and it is clearly only provided to prevent the freezing up of the plant.

The working of the plant is obvious. The ore, limestone, water and oil are introduced into the centrifugal mixer, agitated thoroughly and then the ore passes after being mixed into two vessels which are stated to be for "receiving the ore after the centrifugal mixer," and from these vessels it passes into the vat provided with

the leaden coil. In this vat there is a rake or slow stirring device, which moves at the rate of 10 to 12 revolutions per minute

"so as to prevent the ore from collecting at the bottom in too compact a mass."

Sulphuric acid, containing about 35% of sulphuric acid and 65% of water, enters into the body of oiled minerals and gangue at the bottom of the vat and generates carbonic acid, which gas carries the oiled minerals to the top, where they are either skimmed off or pushed into the launder, which leads them into a discharge hopper, and from there apparently to the filter case. Some of the oiled minerals which have been carried to the surface in the vat
650 provided with the leaden coil, fall back and get mixed with the gangue and they are treated on the purifying screen, which, on being jolted, spreads the material uniformly over the screen in a thin layer and causes the oiled sulphide parts to rise to the top and to be carried forward to the end of the screeen, from where they are removed by a discharge pipe. The gangue passes through the heavy portion of and falls apparently through the screen into the bottom of the tank and from there it falls out through three holes into a system of classifiers, in which any part of the oiled mineral which may be mixed with them can be recovered.

The overflow from the tank provided with the screens and the overflow from the spitzkasten and the concentrates obtained from the vessel provided with the leaden coil by means of the overflow, are all discharged into the filter case, the operation of which is self-evident and need not be described.

The concentrates may be finally subjected to a high pressure in a hydraulic press or in a filter press for the recovery of the oil.

The information contained in these instructions differs essentially from the matter which is revealed in Froment's specifications. It represents the experience which Froment had gathered by further investigation during the eighteen months which had elapsed between the date of the application for Letters Patent and the date when the instructions here were delivered to the complainants.
651 The patent describes only a test tube example. The patent is still under the ban of the Elmore buoyancy oil flotation and considerable quantities of oil are described as having to be used. The quantities of limestone to be used are very large, and as the limestone is for the purpose of generating the carbonic acid from it by means of sulphuric acid, the quantities of sulphuric acid are correspondingly large. The essence of the patent is the statement of a theory illustrated by a test tube test, and there is no description therein whatever even approaching a practical process. There is no process contained in the patent.

The instructions do describe a process and this process consists of two essential steps and of a number of other operations which are not Froment's inventions as far as his new process of concentration is concerned, but only assist in the recovery of minerals from the tailings. This process consists of oiling the minerals in one vessel

in such manner that when the agitated mixture is allowed to settle in a second vessel, the oiled minerals fall to the bottom (operation 1), and in lifting the oiled minerals in the second vessel in which they are very slowly raked like the soil in a garden by a rake making 10 to 12 turns per minute, whilst at the same time carbonic acid is generated. The carbonic acid carries the oiled minerals to the top and they are collected there. The principle involved in skin flotation assisted by bubbles of carbonic acid. The process revealed
652 by the instructions uses widely different quantities of materials from the quantities of the patent. The quantity of oil required varies roughly from one to three and a half parts of oil to one hundred of ore. The carbonate of lime is from one to two parts of lime to one hundred parts of ore, and the acid is to be used in the same proportions as the limestone, namely, from one to two parts of concentrated sulphuric acid (66° Baume) to one hundred parts of ore. He specifies the quantities necessary to get the full benefit of the carbonate of lime, namely, to generate all the carbonic acid which is contained in a given quantity of limestone. There is a passage in the instructions which is rather obscure. Whilst in one place he states the quantity of carbonate of lime to be used to be one part and the maximum to be two parts, to one hundred parts of ore, he says in another place that the carbonate of lime should be like the oil in proportion to the quantity of sulphides and sulphuric acid in proportion to the quantity of carbonate of lime. The difference between the test tube example of the patent and the process of the instructions is as follows:

653 Test Tube Example of the Patent.

Quantities used: 10 grams of ore.
30 grams of water.
1.4 cc. of oil (at least).
1 gram of carbonate of lime (limestone).
1 gram of sulphuric acid concentrated.

All are filled into one test tube, then agitated for a brief space (one second in the Italian specification), the result being a "magma," that is, oil buoyancy flotation assisted by carbonic acid gas.

Process Revealed by Instructions.

(1) Ore de-slimed and mixed with water, one to three and a half per cent. of oil, and one to two per cent. of calcium carbonate, agitated at a speed of 300 revolutions per minute for about ten minutes. Result of agitation; oiled minerals with gangue at bottom.

(2) Mixture of No. 1, whilst being agitated, emptied through intervening vessels into a vessel provided with a perforated leaden coil and a slowly acting rake for turning at a speed of 10 to 12 revolutions per minute the oiled minerals and gangue which had settled at the bottom of this vessel. Sulphuric acid introduced through the perforated leaden pipe and carbonic acid generated,

resulting in oiled minerals attached to gas bubbles floating to the top by skin flotation assisted by carbonic acid gas bubbles.

654 The result of the test tube example described in the patent is a magma consisting of oil, gas bubbles and mineral.

The result of the process revealed by the instructions is skin flotation assisted by gas bubbles.

34 Q. Please now give consideration to the comments by Dr. Byrnes on the Froment British patent and the tests which he has made in illustration of what he has deemed to be the disclosures of this patent, noting that he says, on page 155 of Defendant's Record, that this British patent corresponds to the Italian Froment patent, No. 62,723.

A. Dr. Byrnes, on pages 156, 157 of Defendant's Record, sums up the disclosures which, according to his view, are contained in this patent or in these patents. I agree with (2), that the use of a relatively small amount of oils is disclosed, if Dr. Byrnes means to express thereby that it is a relatively small amount as compared with the amount used in the process which was known at that time as the oil process of ore concentration, of which it is stated to be a modification. If, however, Dr. Byrnes means to state as an absolute fact that small quantities of oil were used in the sense of what we understand a small quantity at the present time, then I disagree. I find the minimum quantity of oil to be 12½ per cent. of the weight of ore. I disagree with (3). Froment states definitely the quantity of limestone which he uses and as this limestone is only added for the purpose of supplying the carbonic acid to be

655 used in this process, it reveals at the same time the quantity of sulphuric acid necessary to decompose the limestone and to liberate the carbonic acid therefrom. I have explained that limestone is carbonate of lime and that it releases the carbonic acid when acted upon by a stronger acid. If a definite quantity of limestone be given, the metallurgist knows at once the quantity of sulphuric acid necessary to liberate the carbonic acid. I agree with (4), with the addition that the brief space is defined in the Italian patent as one second, and in the English and Italian patents, Example 1, a few seconds for agitation and settling. I agree with (6),

"The consequent flotation of the sulfid, rising to the top of the liquid as a distinct magma,"

but disagree that it is a "froth." I have explained the difference frequently. A magma, according to Murray's dictionary, is any crude mixture of mineral or organic matters in a thin, pasty state. In the present case, it is a mixture of oil and minerals enclosing carbonic acid bubbles. A froth is a collection of gas bubbles surrounded by a liquid film on the surface of the liquid. I have the same objection to the use of the word "froth" in (7). Dr. Byrnes states, on page 158 of Defendant's Record:

"Thorough agitation is obviously necessary to distribute the small amount of oil thinly over the innumerable small particles of sulfid to be coated."

656 The patentee does not describe a small quantity of oil and I do not call 12½% of oil of the amount of ore a small quantity, and he does not describe thorough agitation. He says in the English patent that "the mixture is agitated for a brief space;" and in the Italian patent, "for a second." I do not call that "thorough agitation." Dr. Byrnes then recites seven test tube experiments, the bearing of which on the Froment patents I do not understand. As to (1), namely, that 50 cc. of water being contained in a 100 cc. test tube and well agitated, contained air bubbles which quickly disappeared, that is a well known fact. Dr. Byrnes does not state how and for what period. As to (2), I cannot see the relation to the Froment patent, and the same may be said of (3) and (4).

As to (5), Dr. Byrnes states that he added one drop of olive oil to a mixture, which has been gently heated, of 10 grams of Black Rock ore, 30 cc. of water, and a few drops of sulphuric acid, agitated for a brief space, "whereupon a large mass of oiled and aerated mineral floated to the top, in the form of a magma or froth having the characteristics described in the Froment patent." I disagree with the result described, which I could not obtain, but again I cannot understand the bearing of this experiment on the Froment patent. The Froment patent does not describe the heating of the ore with sulphuric acid, it does not describe the addition of one drop of oil to the hot mixture thus prepared, from which no doubt most of the carbonic acid had——

[Copy of cover of volume 3 of transcript of record.]

656½ United States Circuit Court of Appeals for the Ninth Circuit.

No. 3081.

BUTTE AND SUPERIOR MINING COMPANY, Designated as Butte and Superior Copper Company, Limited, a Corporation, Appellant,

vs.

MINERALS SEPARATION, LIMITED, a Corporation; MINERALS SEPARATION AMERICAN SYNDICATE, LIMITED, a Corporation, and Minerals Separation North American, a Corporation, Appellees.

Substituted Pursuant to Order Filed March 19, 1918, for Incorrect Copy Filed November 10, 1917.

TRANSCRIPT OF RECORD.

Volume 3.

(Pages 657 to 1320, Inclusive.)

Upon Appeal from the United States District Court for the District of Montana.

Filed Mar. 19, 1918. F. D. Monckton, Clerk.

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657 —been removed, it does not describe the thorough aeration of the liquid. Again I miss the duration of the agitation. If this experiment is meant as an experiment of the test tube example in the Froment patent, then I distinctly say it is nothing of the kind. I have often mentioned the difficulty which is experienced by many people that they cannot separate themselves from the knowledge of the present day and put themselves into the condition of the knowledge existing at an earlier time. It is impossible for me to conceive for what purpose this experiment has been introduced, as I cannot think that Dr. Byrnes meant to describe it as a Froment experiment. The purpose of experiment (6) is equally obscure and does not contain any contribution with regard to the Froment patent. Why Dr. Byrnes dissolved two drops of cotton seed oil in ether and poured this solution over 10 grams of ore, I do not know. If he thinks that is a better way of distributing the oil over the surface of the ore, then I disagree, as this mode is not conducive to uniform oiling, and why he afterwards heated the ore thus prepared with 30 grams of water and sulphuric acid, is equally incomprehensible to me. The Froment test tube example is simple. Mix 10 grams of ore with one gram of calcite, add sulphuric acid, then a thin layer of oil, agitate for a second and the concentrates will be on the surface of the liquid in the form of a magma.

658 As to (7), the two experiments described in this, one of which is said to be Froment and I assume the other one an imitation of Froment, I say that neither of them is a Froment, and I further say that the description of a thin layer of oil as a few drops is incorrect and not in accordance with the facts. A thin layer requires at least 1.4 cc. of oil, which means, according to the size of the outlet of an ordinary pipette, anything from 49 to 63 drops. I repeat again that there is no warming described in the patent of Froment and there is no warming necessary. As I said before, none of these test tube experiments are in accordance with the test tube example described by Froment, and none of them have any bearing thereon.

On page 165 of Defendant's Record, Dr. Byrnes states that he has

"repeatedly operated the process of the Froment British patent 12,788 of 1902, using the Hyde slide apparatus to effect the brief agitation and frothing, and using different kinds of oil and widely differing amounts of oil."

There is no description of any apparatus in the Froment patent beyond the agitation of the test tube, and there is no description of any frothing. The use of the slide machine is unwarranted and, what is more, it is impossible to produce the Froment result therewith. I have read the five experiments which Dr. Byrnes describes as having been carried out with widely differing amounts of oil.

659 Before going into the details of the description and of the results, I should like to state here that the true test of these experiments is to try with the proportions of the quantities used by Dr. Byrnes, but according to the test tube example described by Froment.

If they are in accordance with Froment, then the results which Froment describes must be obtainable by the test tube experiment.

Adjourned to Tuesday, October 29, 1912, at 10:30 in the forenoon, at the same place.

New York, October 29, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 34 Q. continued: In producing these experiments now, it must not be inferred that they are necessary to show that the experiments of Dr. Byrnes, in which he used the "Hyde slide machine" and the description of which begins on page 165 of Defendant's Record, have nothing to do with the Froment patent. I shall criticise Dr. Byrnes' experiments later on on their own merits. I believe, however, that it will be useful to the Court if I show by a translation of the quantities used by Dr. Byrnes to the corresponding quantities and proportions in which they would be used in the test tube
660 experiments of Froment, the wide difference between Froment and Byrnes, the impossibility of deriving such quantities from Froment and the impossibility of obtaining Froment's result therewith. The first experiment is described in the second paragraph on page 165 of Defendant's Record. The quantities used by Dr. Byrnes are:

492 grams of ore.
.3 cc. of cotton seed oil.
1 cc. (1.8 gram) of sulphuric acid.

If these quantities are translated into the quantities of the Froment test tube example, they are:

10 grams of ore.
0.006 cc. of cotton seed oil.
0.02 cc. (0.036 gram) of sulphuric acid.

0.006 cc. of cotton seed oil equals about one-fourth to one-sixth of a drop of oil. We have no means of dealing with such quantities and I was compelled to use in this experiment a drop of oil. One-fourth to one-sixth of a drop of cotton seed oil represents Dr. Byrnes' conception of a thin layer of oil in a 100 cc. test tube, which he in his experiments relating to the Froment patent used. 0.036 gram of sulphuric acid used by Dr. Byrnes represents one-half to one-third of a drop of sulphuric acid. It is equally impossible to convey this quantity into a test tube and it can only be done by diluting the acid with water and thus increasing the volume. No such descrip-
661 tion is mentioned in Froment and it was not necessary, as he deals with quantities which can be handled.

I took 10 grams of defendant's ore, which had been crushed in my presence to 80 mesh, mixed it with 30 cc. of water, added thereto

0.036 gram of sulphuric acid (which I had to dilute in order to be able to convey it into the test tube), and one drop of cotton seed oil. As I said before, there are no means known of conveying the quantity used in Dr. Byrnes' above mentioned experiment, and I was compelled, therefore, to use six times the quantity of oil that was used by Dr. Byrnes. I agitated them for about one to two seconds, with the following result; practically all the ore was at the bottom, some slimes and oil, which could be observed by its glistening, at the top. (It will be remembered that in the instructions Froment says, that the ore must be de-slimed for his purpose.) I repeated the agitation for about seven seconds in a way which might be really called violent agitation, but the result was the same as before described, namely, absolute failure to produce the Froment phenomenon described in his test tube example, namely, that the whole of the mineral will rise to the top of the liquor and form a magma.

The second example described by Dr. Byrnes and which is contained in the last paragraph on page 165 of Defendant's Record and ending on the next page, has been made with the following quantities:

662 492 grams of ore.
22 cc. of cotton seed oil.
1 cc. (1.8 grams) of sulphuric acid.

These quantities, when translated into the quantities of the test tube example, are:

10 grams of ore.
0.4 cc. of cotton seed oil (14 drops).
0.02 cc. (0.036 gram) of sulphuric acid (1/3 of a drop).

These quantities were mixed, as described in the previous experiment, and the mixture was agitated for two seconds. The result was identical with the one of my previous experiment. Practically all the ore was at the bottom of the liquid, some oil containing some slimes on the top. Even after further vigorous agitation for five seconds the result was not altered.

The next experiment of Dr. Byrnes is identical with the previous one, with the exception that he uses 20 cc. of Ehrmann's California olive oil instead of cotton seed oil, and my experience was identical with my previously described one, with the exception that I used 0.4 cc. of Ehrmann's California olive oil instead of 0.4 cc. of cotton seed oil, and the results were identical with the results of the previous experiment, both after shaking from one to two seconds and after shaking for a further seven seconds.

663 The next experiment of Dr. Byrnes is identical with the second experiment, with the exception that he used 20 cc. of defendant's "red oil," and my experiment was identical with my second experiment above described, with the exception that I used 0.4 cc. of oleic acid, and the results were identical with the results of the two previous experiments, both after shaking for one to two seconds and after shaking for a further seven seconds.

The last experiment of the series presented by Dr. Byrnes and described in the last paragraph on page 166 of defendant's Record contains a slight variation in the proportions, namely:

500 grams of ore.
10 cc. of red oil.
1 cc. (1.8 grams) of sulphuric acid.

The corresponding proportions used by me in a test tube experiment were:

10 grams of ore.
0.02 cc. (0.036 gram) of sulphuric acid.
0.2 cc. of oleic acid.

The experiment was carried out in the same way as the first experiment and the result was the same as described of my other experiments of this series.

The conclusions from these experiments are that it is impossible to produce the Froment result with the proportions between ore, oil and acid which Dr. Byrnes used in the slide machine experiments described on pages 165 and 166 of Defendant's Record, and I say deliberately that it is impossible with such proportions to
664 produce the Froment result of the test tube example, namely, causing the whole of the mineral to rise instantly to the top of the liquid in the form of a magma. It is obvious and self-evident from the result of these experiments that Dr. Byrnes' experiments cannot be in accordance with and are not the invention revealed in the Froment patent.

I will now return to the experiments of Dr. Byrnes. I have calculated the recovery of zinc obtained in each experiment, the amount of zinc left in the tailings, and I have ascertained the loss if there was any occurring in each experiment. In the first four experiments, the quantity of ore used contained 99.9 grams of zinc.

In Experiment 1, Dr. Byrnes recovered.....	85.25	grams
The tailings contained.....	13.25	grams
	98.50	grams,

and there was, therefore, a loss of 1.4 grams.

In Experiment 2, Dr. Byrnes recovered.....	101.9	grams of zinc
The tailings contained.....	2.9	grams
	104.8	grams

Dr. Byrnes, therefore, recovered 4.9 grams more than was contained in the original ore. The margin is rather wider than is usually allowed for errors in the analysis.

665

In Experiment 3, Dr. Byrnes recovered..... 97.0 grams
The tailings contained..... 1.6 grams

98.6 grams,

and there is, therefore, a loss of 1.3 grams.

In Experiment 4, Dr. Byrnes recovered 27.4 grams.
The tailings were not assayed.
There is, therefore, in this experiment a loss of 72.5 grams.
In Experiment 5, the zinc contained in the quantity of the ore used was 101.5 grams.

Dr. Byrnes recovered..... 95.9 grams
The tailings contained..... 3.1 grams

99.0 grams

There was, therefore, a loss of 2.5 grams.

I will recall the fundamental idea on which Froment based his invention. A gas generated in the nascent state will cause minerals moistened by oil to rise to the surface of the liquid. He describes as such gas carbonic acid and he generates it in the nascent state by the action of sulphuric acid on limestone. Metallic carbonates, it may be generally stated, are capable of evolving carbonic acid on addition of sulphuric acid. But the conditions necessary to produce the reaction may vary and do vary widely. The celerity of the reaction depends on a number of factors, namely, whether
666 the carbonate is soluble in the medium in which it is exposed to the action of the acid, whether if soluble it is presented in the very finest powder to the action of the acid, whether even if finely powdered the small particles have a crystalline structure or whether they are amorphous, whether they are individual particles or whether they are enclosed within some other substance resisting the action of the acid. All these factors are of great importance and the rapidity or slowness of the generation of carbonic acid will depend on the selection of a suitable carbonate. Rhodochrosite, which is chemically manganese carbonate, is not readily attacked by sulphuric acid and it requires warming when mixed with a liquid before sulphuric acid will generate carbonic acid from it. I have found that in the state in which it is contained in defendant's ore, even if the ore is crushed to an 80 mesh, it is not readily attacked by sulphuric acid at a temperature of 40° Centigrade (104° Fahrenheit), and Dr. Byrnes observed the same fact. He states, on page 159 of Defendant's Record, in Experiment 4,

"and the mixture was gently heated, whereupon gas was chemically liberated by the action of the acid on the carbonate."

The mixture to which the sulphuric acid had been added consisted of 10 grams of Black Rock ore finely powdered and contained in 30 cc. of water, to which, as described in (4), sulphuric acid

667 had been added. The same fact is described again in Experiment 6, in which 10 grams of oiled ore were mixed with 30 grams of water. 5 grams of sulphuric acid were added to this mixture and

"the whole was gently heated to cause the sulphuric acid to react on the carbonate in the ore."

And the same fact is described in (7) of this series of Dr. Byrnes' experiments, in which he states,

"On warming to start the reaction."

Dr. Byrnes represents the experiments made in the slide machine described on pages 165 and 166 of Defendant's Record as experiments falling under the Froment patent. The result must, therefore, be due to the generation of carbonic acid by the action of sulphuric acid on the rhodochrosite contained in defendant's ore, which he used in these experiments. I am sure, from experiments which I made, that scarcely any action of sulphuric acid on the rhodochrosite can have taken place. It is further a fact that, if the whole of the sulphuric acid had been used up in Dr. Byrnes' experiments, it would be utterly inadequate to produce the result which has been described by Froment. 1 cc. of sulphuric acid represents in weight 1.8 grams, and it is capable to produce 0.8 grams of carbonic acid. 0.8 grams of carbonic acid represents in volume 0.4 of a liter. The solubility of carbonic acid in water of ordinary temperature is one volume of carbonic acid in one volume of
668 water. Dr. Byrnes used in his experiments 1700 cc. equal to 1.7 liter of water, which at ordinary temperature is capable of dissolving practically four times the quantity of carbonic acid which could have been generated if all the sulphuric acid had been consumed. Twice the amount of carbonic acid would have been practically dissolved by the amount of water if the temperature had been 50° Centigrade instead of ordinary temperature or the temperature of 70° Fahrenheit, which is 21° Centigrade, which Dr. Byrnes used. The agitation in the slide machine would assist the solution of the carbonic acid in water considerably and would put it practically out of action for the purpose and the duty which Dr. Byrnes alleges it performed. In the first of his experiments, Dr. Byrnes used a quantity of oil, namely, .3 cc. (.27 gram), for 492 grams of ore. That is, roughly, 1.1 lb. per short ton of ore. I cannot conceive the reasons which induced Dr. Byrnes to describe this experiment as an experiment conducted according to the Froment patent. It differs in principle, in proportions and in the mode of carrying out absolutely from anything which is revealed in the Froment patent. As a matter of fact, it is nothing but the production of the agitation froth carried out according to the process of the patent in suit, such process being understood to mean an agitation such as will commingle air with a mixture of ore pulp with a quantity of oil such as described in the patent in suit in the presence of a small quantity of sulphuric acid. Dr. Byrnes describes in

669 this experiment, which he characterizes as a Froment experiment, that he collected five froths (I will not repeat again and again that Froment does not obtain a froth). I fail to find in the Froment patent anything which could possibly induce a metallurgist to effect the recovery of the mineral by five repetitions of the froth production experiment. On the contrary, Froment states twice that in one operation the whole of the mineral is removed from the ore (Froment British Spec., page 2, lines 37, 38, and page 3, lines 4-6):

"the whole of the copperpyrite will instantly rise to the top of the liquid."

"Only a few seconds were necessary for completely separating the sulphide of copper from the rest of the gangue in which no single trace of copper could be discovered by analysis."

I repeat that Experiment 1 is nothing but the performance of the process of producing the agitation-froth of the patent in suit.

The Experiment 2 differs from 1 that sixty-six times the amount of oil was used therein. The other parts of the mixture, namely, water, acid and ore, are the same as in Experiment 1. All the facts which I stated with regard to Experiment 1 apply therefore with equal force to this experiment. It can never be considered a Froment experiment. The quantity of oil in Experiment 2 is considerably larger than the quantity used in Experiment 1. It amounts
670 to 72 lbs. of oil per short ton of ore. The concentrates produced on the surface of the liquid are both in appearance and character entirely different from the agitation froth of the patent in suit. The oily character of the minerals is clearly visible to the naked eye. I should describe it as a mixture of oil, minerals and air bubbles. My conclusions are the same as derived from the first experiment. The oil quantities are not Froment's quantities; the acid quantities are utterly different from Froment's quantities, and the principle involved is utterly different from Froment's principle. It is the application of an agitation resulting in commingling air with the pulp, oil and ore, which has been for the first time consciously stated in the patent in suit for the purpose of concentrating ores by means of a froth. I need scarcely add that the quantities of oil used in the second experiment render it perfectly useless for manufacturing purposes by reason of the expense for the concentration of ores, even if the concentration were as good as described in this experiment.

The same remarks and criticisms apply equally to the other three experiments.

Experiment No. 4 shows rather exceptional results, as the recovery by three repeated operations, or, as Dr. Byrnes calls it, by three froths, amounted only to 27.4% of the whole zinc contained in the ore. In experiment 5 Dr. Byrnes obtained by the collection of four froths (his term) the recovery of about 95% of the zinc contained in the ore. Dr. Byrnes seems to explain the difference in
671 these two results by the fact that in experiment 4 "red oil," or, as he calls it, "impure oleic acid" was used, whilst in experi-

ment 5 a pure "red oil" had been used, that means, a "red oil" which contained less of the solid fatty acids, namely stearic and palmitic acid. I have analyzed two specimens of defendant's oleic acid, one marked "Specimen 2 of Defendant's Oleic Acid," and which was received by me, through counsel, from Dr. Byrnes as a specimen of the ordinary "red oil" which he had used in his tests, and the other marked "Defendant's Purer Oleic Acid," which was received by me, through counsel, as a specimen received by him from defendant of the purer "red oil" used by the defendant and by Dr. Byrnes in the experiments described in their testimony. The result of this analysis was that these two oils are identical in the amount of palmitic and stearic acid they contain. Both of them contain the same quantity of oleic acid and the same total quantity of palmitic and stearic acid.

The result of this analysis excludes the reason by which Dr. Byrnes seems to explain the difference in result of recovery according to experiment 4 and of experiment 5, to which might be well added the other experiments.

Adjourned to Wednesday, October 30, 1912, at 10.30 in the forenoon, at the same place.

672 New York, October 30, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 34 Q. continued: In the experiment which I carried out in the test tubes, translating the quantities used by Dr. Byrnes for the experiments described on pages 165 and 166 of Defendant's Record into the corresponding test tube quantities, I have stated that, for the experiments described by Dr. Byrnes in the second paragraph and in the last paragraph of page 166 of Defendant's Record, I used oleic acid. I did use oleic acid for the following reasons. Dr. Byrnes states, in the last of the experiments quoted:

"It should be noted that the 'red oil' used in this test was a special or somewhat purer form of oleic acid than that used in the preceding run, more of the solid fatty acids, stearic and palmitic, having been removed by the maker, Charles T. Perry & Co., rendering it thinner and less viscous, pasty or solid at ordinary temperatures."

I have stated that the analysis of the oil in question proved his conclusions to be erroneous. I would however, have taken this oil for these experiments, if not unfortunately the glass bottle which contained it had been broken on the journey from England to this country. In order to satisfy the criticism and objections
673 which Dr. Byrnes offered with regard to the oil which he calls a more impure oil, I selected for use in this experiment a commercial oleic acid which did not contain as precipitates solid fatty acids, stearic and palmitic acids, at ordinary temperature, and

it was free from the objections which Dr. Byrnes seems to attribute the bad concentration results of the first experiments with "red oil."

The analysis which I carried out with the two "red oils" obtained from counsel, as stated before, proves that Dr. Byrnes' explanation of the bad result of concentration of the first experiment with that "red oil" is not borne out by the facts. My explanation is that, in the initial operations, a large quantity of oil may have been removed and that, therefore, in experiments 2, 3 and 5 of this series, proportions between oil and ore were created falling within the proportions revealed in the patent in suit, just as the proportions of Example 1 of the series are the proportions of the patent in suit.

I have calculated the quantities of oil revealed and used in the experiments of Dr. Byrnes, on pages 165 and 166 of Defendant's Record, for a ton of ore, and equally so the lowest quantities of oil which I have found by actual estimation disclosed in Froment, and I state the results in the following table:

Dr. Byrnes' experiments on pages 165 and 166 of Defendant's Record:

674 Expt. No. 1, the quantity of oil 1.1 lb. per short ton of ore;
Expts. 2, 3, & 4, quantity of oil 73 lbs. per short ton of ore;
Expt. 5, quantity of oil 36 lbs. per short ton of ore;

Froment British Patent No. 12,778 of 1902:

Smallest quantities of oil 250 lbs. per short ton of ore.

In complainants' patent in suit the quantity of oil "found suitable and economical" is 2 lbs. of oil per short ton of ore. This quantity may be varied, it may be lower or higher, but the amount stated has been in the experience of the patentees a suitable and economical quantity.

The quantities of oil used by Froment and the quantities of oil used by Dr. Byrnes in his experiments 2, 3, 4 and 5 would render any process in which they were used valueless for commercial purposes. Ore concentration carried out, even with much smaller quantities, for instance, with the quantities which Cattermole described in his specification, were fatal to the commercial success, even if otherwise producing satisfactory results. Figures will be the best illustration. If the price of oleic acid were 5 cts. a pound, the cost involved for the treatment of one short ton of ore would be, for the quantities which Dr. Byrnes used,

For Experiments, 2, 3 and 4	$3.65
For Experiment 5	$1.80
For Froment	$12.50
For Complainants' patent in suit	.10

675 It is true that in processes such as Froment's or as described in Experiments 2, 3 and 4 of Dr. Byrnes, part of the oil would be recovered, but such recovery would involve expense. Furthermore, only part of the oil contained in the concentrates can be recovered as such. A considerable amount remains in the concentrates. But concentrates with such amount of oil would be unsale-

able and this remnant has to be removed by chemical agents, which again is a costly operation.

Adjourned to Thursday, October 31, 1912, at 10:30 in the forenoon, at the same place.

New York, October 31, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 34 Q. continued: I have stated that the oil which is left in concentrates cannot be all removed therefrom, even by high hydraulic pressure or by filter presses. A considerable amount remains. I have estimated the amount, that is, I have ascertained the amount by analysis, and I have found that, after exposing a mixture of oil and concentrates to the highest pressure that I could produce, which pressure was far in excess of the pressure obtainable by filter presses, the amount of oil left in the concentrates to be 9%
676 in weight of the concentrate. It is possible to remove such quantity by after treatment with chemical agents, if the oils belong to the class of vegetable or animal oils. In such case, a treatment with caustic alkalis will dissolve them, but naturally there is the cost of the chemical agent and the cost and working expense of this treatment to be added to the first expense. The oil is obtained in a form commonly called soap, and to recover it for the purpose of use in ore concentration, it must be treated with acids. A soap is like a carbonate, a salt. That means, the combination of an acid with a metallic base. In carbonates the acid is carbonic acid. In soaps the acid is a fatty acid like oleic acid. By the action of the stronger acid on soap, the metallic base contained in soap combines with the stronger acid and the fatty acid is liberated in this process. This operation again involves cost for chemical agents and additional working expenses. If fatty oils, such as olive oil or cotton seed oil, have been used, it is impossible to recover these by the treatment with alkali. They would be decomposed and converted into fatty acids by such treatment. The only treatment would be to extract them with solvents, which is quite out of the range of a process like ore concentration. The cost would be enormous and the result would be again that instead of losing the oil, a portion of the solvent would be lost. What is more, the solvents suitable for the purpose are of a highly inflammable character and would be dangerous to use. If heavy mineral oils remain in the concentrates, they cannot
677 be removed by caustic soda in any form and they have to remain in and are a loss. They could be removed by extraction with other solvents, but that process is quite out of the question and impossible, both on the consideration of cost, which would be enormous, and owing to the inflammability and danger of the extracting solvents which would have to be used. It is a fact that any process of ore concentration, which results in the leaving of considerable quantities of oil in the concentrate, will be highly costly, even if part of the oil can be recovered by filter presses or hydraulic presses.

I have stated what, in my view, is the true reading of the Froment specification, No. 12,778 of 1902, and what is revealed therein. Dr. Byrnes has not produced a single experiment which can be called an experiment truly carried out according to the Froment patent. His test tube experiments have nothing whatever to do with it. His experiments on pages 165 and 166 have nothing whatever to do with it. I have not repeated them. I have not considered it wise to chase these hares which have been pushed into our road to detract attention from the real issue of this case, to complicate its simple issues and to confuse them. Dr. Byrnes states that he has produced in the first experiment of the series a froth of concentrates. There is nothing surprising in this. He used the process which for the first time in the history of ore concentration was revealed in the patent in suit, and he practically used the quantities which are described therein
678 as being suitable and economical. He commingled, by brisk agitation, air, ore and traces of oil, traces so small that they cannot be translated into the test tube experiments of Froment. He produced the agitation froth. He did not learn that from Froment, but he learned it from the patent in suit. He then used the same process with very much larger quantities of oil and states again that he obtained a froth. There may be what is popularly called a froth, but this froth differs in characteristic qualities from the froth produced with the quantities of oil described by the patentees of the patent in suit as suitable and economical. It contains large quantities of oil which are quite visible and can even be detected by the touch. The appearance of the minerals is changed. They have a dull look and lack the metallic luster of the minerals. The agitation froth produced with the quantities of oil which the patent in suit informs you are suitable, does not disclose the presence of any oil. The faint traces of oil which must be there are absolutely invisible and only a careful chemical analysis can show their presence. To the touch the concentrates thus obtained are the same as the ordinary mineral which had never been treated with any oil. I cannot understand why Dr. Byrnes produced these experiments. He only proves that he can produce, with much larger quantities of oil than are considered economical by the patent in suit, a froth, but at the same time he proves that the quantities recommended as economical in the patent in suit are economical. It frequently occurs in patent
679 litigation that a defendant will make an untenable defense by alleging that he produces a result by different quantities, sometimes by much larger quantities, but, of course, such a defense must always fail. It is no defense to use the essence of the invention and produce only a result which increases the cost of production in such an enormous way as the cost would be increased if quantities of oil were used such as described in experiments 2, 3, 4 and 5 of the series described in Defendant's Record, pages 165 and 166. I have stated my views on the Froment patent and on the Froment instructions fully, and I need only repeat once more that there is nothing contained therein which would enable anybody to produce the agitation froth of the patent in suit, and furthermore, that there is

nothing contained therein which might lead an investigator even in the direction of the invention of the patent in suit.

By Mr. Scott: That part of the preceding answer beginning with the words "I have not repeated" and extending to the words "confused them;" that part of the answer beginning with the words "It frequently occurs" and extending through the words "pages 165 and 166," are objected to as being merely argumentative and embodying no statements of fact or of opinion upon any matter concerning which the witness is qualified to testify, or would be competent to testify in any event.

680 35 Q. I call your attention to the statement of Dr. Byrnes appearing in Defendant's Record on page 170, referring to the Froment patent or patents, as follows:

"Froment, as I have noted, confines his description to the process and its principles, leaving the type of agitator to be determined by the user. In his test tube experiment, agitation sufficient to coat the mineral particles with a thin film of the oily agent also thoroughly aerates the mixture, the fine bubbles of air distributed throughout it, and attaching themselves to the oiled particles, acting with the chemically-evolved gas to float them."

What have you to say to this statement?

A. The first sentence of this quotation is utterly wrong in the main statements, and it is only true in one fact, namely that Froment describes some principles. There is no process described, only a test tube example, and as for the fact that he leaves the type of agitator to be determined by the user, that is only a wild flight of imagination. I said there is no process described, and the word "agitator," as referring to the commercial process, does not occur in the specification.

The second sentence is not correct. The British patent states that a mixture of ore, oil in substantial quantities, limestone, water and sulphuric acid is to be agitated for a brief space, and further on says:

"Only a few seconds were necessary for completely separating the sulphide of copper from the rest of the gangue in which no
681 single trace of copper could be discovered by analysis."

The Italian patent makes the same statements, except that it says, "a second," instead of "a brief space." There is not a single word contained in the Froment patents referring to aeration, and what is more, I have proved definitely that it is impossible to produce aeration according to the test tube experiments described by Froment. If Froment had had any conception of aeration, he certainly would have described it. It is not the case that the mineral particles are floated by air. They are floated by the carbonic acid generated in the nascent state in the mixture. This is the whole of Froment's disclosure, and this is all that results from testing his disclosures.

36 Q. Have you tested the Cattermole process as applied to Defendant's ore, and, if so, what have you done?

A. I have tested the Cattermole process as applied to Defendant's ore, and I have carried out three experiments with regard to it.

1. I used 400 grams of Defendant's ore which had been crushed in my presence to 80 mesh, and made a pulp with 1500 cc. of water

containing 0.25% of sulphuric acid. To this pulp I added 7.3 grams of oleic acid, which corresponds to 6% of oleic acid on the zinc sulphide content of the ore, and 1.8% on the ore. The whole mixture was contained in a cone mixer or Gabbett and was agitated
682 for ten minutes. It was then, whilst being agitated, emptied out into a classifier in which an upcurrent of water was maintained. The slimes separated in the overflow, whilst the granules fell into a bottle which was fixed at the bottom of the classifier. After the contents of the cone mixer had been completely emptied out and treated in the classifier, the body was withdrawn and the granules filled into a bottle, which I marked "Cattermole Granules 1."

2. 500 grams of Defendant's ore, the same as described in experiment 1, were made into a pulp with 1500 cc. of water containing .25% of sulphuric acid, and 9 grams of oleic acid (6% on the zinc sulphide content of the ore, and 1.8% on the ore) were added thereto. The whole was agitated for ten minutes in the same cone mixer. It was then introduced in the same manner as described in experiment 1 into the classifier. The granules thus obtained were put back into the cone mixer and the same quantity of water containing 0.25% of sulphuric acid was added to them, and the mixture of water and granules was agitated for ten hours. The granules were then collected in a classifier, as before described. They were filled into a bottle, which I marked "Cattermole Granules 2."

3. 400 grams of the same ore were mixed with 1500 cc. of water containing 0.5% of sulphuric acid, and 8½ grams of oleic acid (7% on the zinc sulphide content of the ore) were added. The mixture was agitated in the cone mixer for ten minutes and the gran-
683 ules were then separated in the classifier, as before described. The granules thus obtained were put back into the cone mixer and the same quantity of water was added as was originally used. The baffles were then removed and the mixture was agitated for nine and a half hours. The granules were then collected in the same way as before described in a classifier, and a number of the larger ones filled into a bottle, which is marked "Cattermole Granules 3." This experiment was carried out according to the alternate method given on page 3, line 46, of the Cattermole patent:

"With certain ores it may be preferable to use in some stages of the process a rolling form of agitation, as in cylinders or barrels, to obtain good granulation of the mineral."

The mode of preparing the specimen "Cattermole Granules 1," is in accordance with the process which would be worked on a manufacturing scale. Experiments 2 and 3 were carried out with the intention of securing very hard and lasting granules to be used as exhibits, and for this purpose the rolling was continued for nine and a half to ten hours. These latter two experiments are not intended to represent the working of the process as carried out in manufacture.

The three specimens produced by the witness are offered in evidence and marked, respectively:
684 "Complainants' Exhibit, Cattermole Granules 1;"
"Complainants' Exhibit, Cattermole Granules 2;" and,
"Complainants' Exhibit, Cattermole Granules 3."

37 Q. Please now give consideration to the testimony of Dr. Byrnes relative to the patent in suit as appearing in his answer to Q. 4, pages 110 et seq., of Defendant's Record, and again at pages 167 et seq., of Defendant's Record, making such explanation of your own knowledge of the same subject matter as may clear up the matters referred to.

A. It is true that the patent in suit makes use of the well-known property of minerals that they have an affinity for oils, whilst the gangue practically repels the oils. It has been stated in this evidence that this fact is as old as at least Herodotus. Anyhow, it was clearly established in Haynes' specification applied for in 1860, and since then a number of attempts have been made to solve the difficult problem of ore concentration by this method. They have all failed, although two of them, namely, Elmore and Cattermole, have been practically used. They disappeared as soon as the new invention which forms the subject matter of the patent in suit, was made. The patent in suit was the final solution of a problem to which, as the number of patents offered by the defendant proves, a great
685 many inventors had applied their ingenuity, their energy and time and labor, and had been unable to accomplish the result. It happens frequently so with great inventions. The results are not obtained suddenly. Very often a large number of years pass by, every year containing a contribution which remains sterile, until finally the right way is found and the world enriched thereby. I need only mention the Tungsten filament. Efforts of very great men have been directed for over thirty years to make a metallic filament of tungsten. All kinds of methods were used, but the results were futile. Only in 1905 the problem was solved and the carbon filaments, which formerly were the only ones used, practically disappeared altogether. The arrival of the tungsten filament signified great economical progress. In the same way, the arrival of the process of the patent in suit signified great economical progress in the mining industry. Inventions are scarcely ever revelations of new laws. Such an invention is an event to be remembered. In nearly all inventions, even those of the greatest importance, the old methods are used and new facts established thereby, which are beneficial to the community. Wireless telegraphy depends on the production of Hertzian waves discovered by the great successor to Prof. Clausius at Bonn. Marconi only found a receiver for these waves. But is this invention less great, less beneficial and less important because Marconi used the Hertzian waves? Herodotus, or, to mention the later inventor, Haynes,
686 found the preferential affinity of minerals for oils. Carrie Everson discovered that that preferential affinity was rendered more valuable and more pronounced if acid was present in an ore pulp. The gangue thereby was prevented from any attachment to the oil. But does that take away from the merit of the patentees of the patent in suit? Does it do away with the fact that they enriched the world with a new, valuable and greatly successful process for ore concentration, which many had attempted before, but which none had succeeded in?

Dr. Byrnes then continues his description of the document. He mentions for reference the Cattermole patents contained in the patent

in suit, and then states the invention, and recites the factors quoted in the patent as assisting the invention. As to (1), the statement of the patentees is quite correct. The addition of acid is not for the purpose of generating a gas. It is simply to prevent the gangue from being coated with the oily substance. And the further statement that

"the proportion of acid used is insufficient to cause chemical action on the metalliferous minerals present,"

is also true, as I have experimentally proved. An ore containing zinc sulphide and galena was subjected to the action of sulphuric acid of a concentration such as specified, for some time, and no zinc was
687 found in the solution. If the acid had acted on the zinc sulphide, zinc would have been discovered in the acid solution. Lead sulphide or galena cannot be attacked by sulphuric acid under such conditions; that is a well-known chemical fact.

Adjourned to Friday, November 1, 1912, at 10:30 in the forenoon, at the same place.

New York, November 1, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 37 Q. continued: Dr. Byrnes continues in the enumeration of the conditions which assist in the realization of the discovery, warming of the mixture of the pulp, fine pulverization of the ore and the fact to which the patentees specially draw attention that the slime mineral most readily generates scum and rises to the surface. Dr. Byrnes includes within the number of factors or conditions which assist this small amount of oil in coating the metalliferous matter and forming a froth, the statements (4) and (5) on page 111, that the proportion of mineral which floats in the form of a froth varies considerably with different ores, and with different oily substances. This is really a warning that it is impossible to describe in a docu-
688 ment such as a patent specification the details of a process which is capable of being carried out with every one of the innumerable ores in existence. The patentees only can give examples and the essence of the invention, but as they say, a simple preliminary test, now the facts are known and the new process described, will give you all the information which is required. Dr. Byrnes continues his description and refers to a specific example contained in the specification, but he has here overlooked the important statement:

"The minimum amount of oleic acid which can be used to effect the flotation of the mineral in the form of froth may be under 0.1 per cent. of the ore; but this proportion has been found suitable and economical."

This statement is of significance. Even at the time when the inventors could have only a comparatively small experience, they found the proportion of oil in quantities of 0.1 per cent. to one hundred parts of ore suitable and economical. In the number of years which

have passed since the filing of this specification, this experience has been confirmed, and proves the power of exact and careful observation of the patentees. In the description of this example, the patentees also called attention to the fact that the power of flotation of the froth is mainly due to the inclusion of air bubbles introduced by the agitation. That is quite correct. In the former attempts,
689 it was the reduced specific gravity of a mixture of large quantities of oils with minerals, sometimes assisted by the inclusion of air or gas bubbles, to which the flotation was due. These were the oil buoyancy flotation processes. In the agitation froth process, the oil, although specifically lighter than water, is present in such small quantities, in quantities which I called before infinitesimal as compared with the quantities of oil used formerly for flotation processes, and infinitesimal as compared with the quantity of mineral which they have to coat, that it scarcely plays any part in the flotation of the minerals. The flotation of the minerals is mainly due to the inclusion of air bubbles.

Dr. Byrnes continues the description of the process of the patent in suit, showing how the froth can be removed, and then describes that part of the specification which forms the subject matter of two separate patents. He explains the drawings contained on Sheets 1 and 2. I find on page 115 the statement, of which I said he had overlooked it, namely:

"an amount of oleic acid constituting 0.1 per cent. of the ore has been found suitable and economical for effecting the flotation, but that smaller amounts may be used."

The patentees say that the amount of 0.1 per cent. of oleic acid in proportion to the ore is suitable and economical

"to effect the flotation of the mineral in the form of froth."

690 The way Dr. Byrnes explained this passage might have been misunderstood because he does not say what kind of flotation the patentees refer to, whereas the patentees specifically say, as above quoted, that a suitable and economical proportion "to effect the flotation of the mineral in the form of froth" may be under 0.1 per cent., but that 0.1 per cent. has been found "suitable and economical." I may add that later on in his deposition Dr. Byrnes appears to have forgotten that the patentees found the proportion of 0.1 per cent. of oil "suitable and economical."

Dr. Byrnes' description of the claims is inaccurate, but as the claims themselves are clear, it is not necessary for me to comment on it, particularly as Dr. Chandler has heretofore fully explained them (Complainants' Record, pages 95-100), and Dr. Byrnes does not criticise Dr. Chandler's explanation.

Dr. Byrnes has overlooked the passage on page 2, lines 40-45 of the patent in suit, as follows:

"The proportion of mineral recovered in the froth and that recovered by table flotation may be considerably varied; but, generally

speaking, the froth will separate the slime mineral while the larger particles are recovered by the latter method."

This statement is very important, as it foreshadows the possibility of a grinding of the ore which would render unnecessary the supplementary treatment of the tailings described in the
691 patent remaining at the bottom of the spitzkasten. This forecast has been realized in the practical working of the agitation-froth process. The grinding of the ore is carried out in such manner that practically the whole of the mineral is recovered therefrom by the agitation-froth process and no other treatment is required for the tailings; they are left clean. This statement is further important in this respect. By no other practical process, with the exception of Cattermole, slimes could be treated. In the process of the patent in suit, not only can slimes be treated, but the presence of slimes is highly beneficial.

In Dr. Byrnes' answer to Q. 4, which I have just considered, I think that, with the exception of a few omissions, to which I have called attention, Dr. Byrnes has given a fair explanation of the patent in suit. It is not enthusiastic, but, of course, it could not be expected to be enthusiastic.

It is a suitable place here to give my experience of the working of the patent and to describe such experiments which will be of assistance in showing that the statements made in the patent are correct. I have seen the process carried out several times in the plant at the Works of Minerals Separation, Limited, in London. This plant is capable of treating fifty tons of ore a day of twenty-four hours. It is practically the same as that shown in the drawings "Complainants' Exhibit, King John's Court Standard Plant," with the exception that another spitzkasten has been added in
692 front of the agitating box marked 3, so that there are six spitzkasten, instead of the five shown in the drawings, and that the deflector F was not present. I saw on the spitzkasten large quantities of the froth, which I have characterized before, sometimes three or four inches deep. I have also made numerous tests in the slide machine and in the cone mixer or Gabbett, and I have used for these tests different ores and different oils. I usually succeeded with the quantity of oil, namely, 0.1 per cent., which is recommended in the patent as "suitable and economical." In one instance I found the addition of .025 per cent. to 1 per cent., making a total of .125 per cent., was necessary for the production of a good froth. This was with palm oil. With linseed oil I got the best result with .2 per cent.

I tested also the statement that the power of flotation of the mineral as a froth is due to the inclusion of air bubbles introduced by the agitation. The way to determine the accuracy of this statement is very simple. The gases contained in the froth are collected in a bottle and are then subjected to gas analysis. A suggestion has been made by the defense that the gas which causes the formation of the froth was carbonic acid and not air. In order to prove finally and definitely whether air or carbonic acid is the agent which effects the formation of the froth, I selected the conditions carefully in

such way that I was bound to find the maximum amount of carbonic acid which could participate in the formation of a froth.

693 I collected, in experiments which were made with the fifty-ton plant in the works of Minerals Separation, Ltd., the gases from the froth appearing on the first spitzkasten, where, if there is any carbonic acid formed at all, most of it must collect. In one test the gases collected from the froth resulting from the treatment of an American copper ore showed 98.7 per cent. of air and 1.3 per cent. of carbonic acid. No acid had been used in the treatment of this ore and the 1.3 per cent. of carbonic acid must have been obtained from the atmosphere. In another experiment, in which Broken Hill tailings were submitted to the process of the patent in suit, 96% of air was found and 4% of carbonic acid. A third sample of gas, which was collected at a different time but from the same ore, namely, the American copper ore, referred to in the description of my first test showed on analysis 98.8% of air and 1.2% of carbonic acid. It will be remembered that no acid had been used in this process. Carbonic acid is always present in small traces in the atmosphere and more so in places where illuminating gas is continuously used, like in the Works of Minerals Separation, Ltd. I made further a number of gas analyses of gases collected from froths which were obtained according to the process of the patent in suit in the slide machine. The narrow confines of this machine would result in showing the utmost quantities of carbonic acid which could be present in any froth. I used a sample of defendant's ore which had been treated with acid for eighteen hours for the purpose

694 of showing that none of the values had been attacked thereby. The treatment was as follows: 400 grams of defendant's ore, crushed in my presence, were made into a pulp with 1,000 cc. of water, and 9 grams of sulphuric acid were gradually added thereto in quantities of one gram at a time. Then the mixture was allowed to stand for eighteen hours. The ore was collected on a filter, washed thoroughly until neutral, and was then used for the production of a froth according to the patent in suit. The acid added was in the ratio of 10 lbs. per ton of ore. The analysis of the gas revealed the presence of 97.1% of air and of 2.9% of carbonic acid. In another experiment I used the ore marked "Defendant's Feed to Flotation Plant." The froth was produced without the addition of acid and the gas collected from it consisted of 100% of air. No carbonic acid was found. Another sample of gas collected from a froth produced by the process of the patent in suit from the ore marked "Defendant's Feed to Flotation Plant," in which production sulphuric acid had been used with a ratio of 10 lbs. to the ton of ore, showed as a result of analysis the presence of 90.7% of air and 9.3% of carbonic acid. Another sample of gas collected from the froth produced from a French ore in the presence of sulphuric acid (ratio 10 lbs. of acid per ton of ore), showed on analysis 98.8% of air and 1.2% of carbonic acid. I also collected a sample of

695 gas from a froth produced according to the process of the patent in suit from a San Francisco del Oro ore, in the presence of sulphuric acid (ratio 60 lbs. of acid per ton of ore). This

ore is distinguished by the fact that it contains from 4 to 5 per cent. of limestone. The analysis of the gas showed the presence of 77.5% of air and 22.5% of carbon dioxide.

It is clear from these analyses that the statement of the patentee is perfectly correct, that it is even correct in the abnormal circumstances which occur in the San Francisco del Oro ore, which contains an extraordinary amount of limestone, and, therefore an extraordinary opportunity for the generation of carbonic acid. It will be noticed that in this experiment I added six times the amount of acid that was used in the other experiments. It was made by me because I wanted to find out the largest quantity of carbonic acid which could be obtained in the gases present in the froth. All the experiments were made at a temperature of 55 degrees Centigrade, so that I would have as much carbonic acid as possible in the gaseous form and not in solution in the water. Carbonic acid is soluble in water at ordinary temperatures in the ratio of one volume of carbonic acid to one volume of water. At 55 degrees Centigrade (131 degrees Fahrenheit), the solubility of carbonic acid gas in water is at the ratio of less than half a volume to one volume of water, and at this temperature, therefore, a much larger quantity of carbonic acid
696 can be in gaseous form than at ordinary temperatures.

I repeat that the statement of the patentees that the froth derives

"its power of flotation mainly from the inclusion of air bubbles introduced into the mass by the agitation"

is perfectly correct. I have explained before that, in my view, the word "mainly" refers to the carrying power of air as contrasted with the carrying power of the small quantity of oil present. It might be said that the gas contained in the froth consisted mainly of air and some traces of other gases. But the statement is correct, whichever explanation might be preferred.

My examination of the patent, which I have made as thoroughly as possible, has shown me that the patent contains a valuable invention, that the invention is fully described and does not offer any difficulties in its performance, and that the facts stated are accurate. I can quite understand the remarkable practical results from this invention which are revealed by the testimony.

Adjourned to Saturday, November 2, 1912, at 10:30 in the forenoon, at the same place.

697 Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 37 Q. continued: Dr. Byrnes says, on page 167, that he has made some tests of the apparatus shown in Figure 1 of the patent in suit. I have seen this apparatus, marked "Defendant's Exhibit, Apparatus of Patent in Suit." It does not contain a cone mixer.

It has a copper vessel of the same general shape indicated by the diagram Figure 1 of the patent in suit and it has a revolving cone, such as is indicated in Figure 1. It is not a cone mixer because it has no baffles for breaking up and mixing the fluid. Dr. Byrnes even calls it a "cone mixer." He apparently does not know a cone mixer. The cone mixer in 1905 was a well-known patented apparatus for mixing fluids and semi-fluids. It is disclosed in United States patent No. 444,345, issued January 6, 1891, to E. R. Gabbett, assignor of one-half to Boulton, Haywood & Boulton. This patent also says that patents have been obtained for this invention in Great Britain, Belgium and France. I have also seen the British patent No. 840 of 1889, and have read it and find that it does correspond with the United States patent, which I have also read. Messrs. Boulton, Haywood & Boulton were probably the surviving members of the well-known firm of Burt, Boulton & Haywood, to whom the British
698 patent was issued jointly with E. R. Gabbett, the inventor.

As I have said before, I was familiar with this cone mixer before 1905. I was familiar with it in the form of a cylindrical vessel having stationary baffles, although the Gabbett patents say that the vessel may be rectangular and the baffles would not then be necessary, or that the cone may have its direction of rotation "reversed after any desired intervals of time" (British patent, page 3, line 30; U. S. patent, page 2 lines 18, 19). If, therefore, the cone mixer in cylindrical form is to be used without baffles, it must have its direction of rotation reversed at desired intervals. If it is rotated continuously in one direction, you must have baffles that stand still while the cone rotates.

The cone mixer is diagrammatically shown in Figure 1 of the patent in suit and in the patent in suit it is particularly described as a "cone mixer" (Spec., page 1, line 84). It is also diagrammatically shown in the Cattermole patent No. 777,273, and there the cone mixers diagrammatically shown are merely described as "mixing vessels" (Cattermole Spec., page 1, line 82). It is also diagrammatically shown, in Cattermole patent No. 763,259, issued June 21, 1904, and in Cattermole patent No. 763,260, also issued June 21, 1904, and in both these patents the cone mixers diagrammatically shown are described as "mixing vessels." These three prior patents give substantially the same diagrammatic indication of the well-known cone mixer as in Figure 1 of the patent in suit. The cone mixer is
699 shown in "Complainants' Exhibit, Young Advertisement A" in substantially the same way. The necessary baffles of the practical working apparatus are not specifically outlined in the diagrammatic pictures. This advertisement in the journal of the Society of Chemical Industry must have been seen by a large number of people, both in Great Britain and America, as this journal has a wide circulation in both these countries.

I have carried out an experiment with the apparatus illustrated by Figure 1 of the patent in suit, and I used for this purpose "Defendant's Exhibit, Apparatus of Patent in Suit," adding, of course, thereto the necessary baffles. 500 grams of Defendant's ore, crushed in my presence to 80 mesh, were made into a pulp with 3200 cc. of water

containing .5% of sulphuric acid. The temperature of the mixture was 35 degrees Centigrade (95 degrees Fahrenheit). 0.75 cc. of oleic acid were added thereto, and the mixture was agitated for about ten minutes. It was then allowed to settle and showed a froth of about one and a half inches in depth. After re-agitation, the mixer was emptied out into the spitzkasten, which were filled with water having the same temperature as the mixture in the cone mixer. A froth appeared filling about the two first spitzkasten. It was collected on filters dried and weighed. Its weight was 107 grams. The
700 tailings recovered from the spitzkasten, looked clean. It is unfortunate that the whole of the Gabbett apparatus cannot be completely emptied out. The residue contained therein, which had the appearance something like the original ore, weighed 136 grams. To collect this residue, it was necessary to pour water into the Gabbett and tilt the Gabbett over and let it run into another basin, and to wash with the wash bottle the Gabbett out. Naturally the froth was broken up, and sunk in this operation and mixed with the tailings, and the impression from superficial observation was that the color resembled the color of the ore. If the apparatus were used as it is intended for continuous work, such residue would not result because there would be continuous addition of new pulp and the residue would be treated with the new pulp. There could only be in a day's work one residue left, which would not appreciably influence the result of the recovery. As a matter of fact, it would have no influence, as it would be treated the next day.

An assay of the 107 grams recovered showed the presence of 49.5% of zinc.

Adjourned to Monday, November 4, 1912, at 10:30 in the forenoon, at the same place.

701 New York, November 4, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

Answer to 37 Q. continued: The quantity of zinc contained in the 107 grams of concentrates recovered as described in the previous experiment in the apparatus marked "Defendant's Exhibit, Apparatus of Patent in Suit," was 52.9 grams. The 500 grams of ore used in this experiment contained 18.5 per cent. of zinc; that is, 92.5 grams. The recovery, therefore, would be 57.2%. I have, however, explained that 136 grams remained in the cone mixer, as they could not be run into the spitzkasten. The zinc content of these 136 grams was 15.1% of zinc, or 20.5 grams, and these 20.5 grams have to be deducted from the zinc content of the ore submitted originally to the treatment by the process of the patent in suit. The zinc content of the 500 grams of ore was 92.5 grams, which, after the deduction of the 20.5 grams of zinc remaining in the cone mixer, leaves a zinc content of 72 grams in the ore, on which an actual recovery was

obtained, and this recovery was 52.9 grams or 73.5%. The tailings weighed 245 grams and contained 5.3% of zinc, that is, 13 grams.

702 I used 500 grams of ore originally. I recovered as

Concentrates	107	grams
Residue in cone mixer	136	"
Tailings	245	"
	488	grams

I, therefore, lost in this operation 12 grams or 2.4% of ore. The zinc content of the ore was 92.5 grams. I found in the

Concentrates	52.9	grams
Residue in cone mixer	20.5	"
Tailings	13	"
	86.4	grams

I lost, therefore, 6.1 grams of zinc, equal to 6.6% of zinc. This loss is easily accounted for by a permissible error in the different assays and by the loss of the 12 grams of ore in the operations. The 12 grams of ore represent the zinc content of 2.2 grams of zinc.

I have frequently made experiments with this apparatus and I have never failed to produce a froth on the spitzkasten. The froths varied in size and covered sometimes only one spitzkasten, sometimes two, sometimes nearly two, of the apparatus marked "Defendant's Exhibit, Apparatus of Patent in Suit." I attribute these variations to the imperfect arrangement in the tap of the outlet pipe of this apparatus. This outlet pipe is provided with a globe valve, that is,
703 a valve in which the water flows first upward, then downward, and then again upward, when the tap is unscrewed; the gangue has time to settle and prevents the flow of the mixture contained in the cone mixer. This occurred in every experiment which I made with this apparatus and the passage of the mixture contained in the cone mixer had to be started by vigorous suction. The valve ought to have been a gate valve, which forms, when the tap is unscrewed, a straight line with the two connecting pipes. But even in spite of this unsuitable valve, the recovery was always obtained as a froth.

I gather from the cross-examination of some of the witnesses, that the defendant contends that a froth is not always formed, but that the recovery is sometimes the result of skin flotation. That is not so; it is always a froth. I have tested this in every experiment I made with the apparatus marked "Defendant's Exhibit, Apparatus of Patent in Suit." In every experiment I made, I allowed the mixture first to settle in the cone mixer after agitation, and in every instance a heavy froth separated. Mr. Sulman suggests the possibility that the force of surface tension of a large bare water surface might cause the expanding of the froth and change it into skin flotation. I have seen the ends of a froth, when a large, free water surface was left,

stretch out and present the appearance of skin flotation. But on close examination, air bubbles densely covered with minerals were
704 seen. But, even if the froth should stretch or expand under abnormal conditions into skin flotation on being exposed to the force of a large bare surface of water, either in the beginning of the daily work or perhaps owing to a breakdown of the machinery, surely that has nothing to do with the real question, namely, that the result of the agitation in complainants' process is the formation of a froth. This froth results always from complainants' process. It is immaterial whether it is collected after its formation either as froth or as skin flotation, or whether it is sunk in the tank and destroyed and collected as finely divided minerals. Any form of collection may be used which prevents its remixing with the tailings. The real invention contained in complainants' patent in suit is the separation of minerals from ore as a froth by agitating a mixture of pulp and oil in such manner that air is beaten in and that, after allowing the mixture to settle after the agitation a froth carrying the oiled minerals forms on the surface of the water.

I have said before that the apparatus, Figure 1 of the patent in suit, is intended for continuous work, and it is stated, page 2, line 53, that there may be any number of cone mixers in series. The number of cone mixers to be used, it is self-evident, would be such as to make the best use of the spitzkasten, to keep them completely covered with the froth so as to prevent the breaking of the froth, and to keep the circuit in continuous activity. I notice on page 167 of De-
705 fendant's Record that Dr. Byrnes describes experiments with the apparatus offered in evidence and marked "Defendant's Exhibit, Apparatus of Patent in Suit." He does not mention that he experienced any difficulty in emptying the cone mixer through the valve with which it is provided, into the spitzkasten. I can only repeat what I have said before, that I had to apply suction in every experiment I made. He also succeeded in fully emptying the cone mixer into the spitzkasten, in which operation I failed. He says:

"The cone being maintained in motion, wash water was added to remove the residue, and the vessel was slightly tilted to empty out the portion contained in the concave bottom."

I cannot conceive how the cone mixer could be tilted up whilst the agitator was running and running at 1600 revolutions a minute. I know of no way how this can be done. Furthermore, the operation of pouring in water from a height on a froth might easily result in the mineral being sunk and removed from the sphere of concentration. But the chief objection to this experiment is, that Dr. Byrnes did not carry out the instructions of the patent to introduce air into the mixture of pulp and oil by agitation to form the froth. The cone mixer used was without baffles, that is, without the element necessary for the introduction of air into a liquid, and the necessity of the presence of baffles would be obvious to any metallurgist, whether he knew of the apparatus or not. The patent clearly
706 says that the agitation must introduce air, and Dr. Byrnes might have readily used one of a number of apparatuses of which he says later on in his summary that they could have been

used for such purpose according to his experiments, and one of which had been described for introducing air into a liquid by agitation to effect a chemical action, namely, oxidation, in the process of the gold recovery by means of cyanide solutions (Stoveken Patent No. 729,805). Dr. Byrnes used the cone mixer without baffles and he succeeded, even with this defective apparatus, to produce some froth. He says (page 167):

"Some froth floated down the shallow trough and over the body of the water contained in the spitzkasten, passing on into the launder and being collected and filtered."

Dr. Byrnes continues on the same page as follows:

"Considerable mineral, in the form of fine individual oiled particles, also floated down on the surface of the water, as a mere film supported by surface tension."

This shows clearly that there was an insufficiency of air to produce a froth, but that some air was introduced which effected skin flotation, if Dr. Byrnes was right in his observation that what he saw was

707 skin flotation and not an expanded froth including fine air bubbles covered densely with minerals such as I have seen to occur sometimes in this apparatus.

Dr. Byrnes used in this experiment .135% of oil of the amount of ore treated. That is a quantity near enough to the quantity found by the patentees as "suitable and economical," and which statement Dr. Byrnes has recorded in the beginning of paragraph 2 of page 115 of Defendant's Record. I was surprised to find, in the first paragraph contained on page 180 of Defendant's Record, no reference to this statement. Dr. Byrnes had apparently quite forgotten it, although it forms the keystone to the ordinary working of the process. He says that the patent

"in the specific 'example' simply specifies 'a very small proportion of oleic acid (say, from 0.02 per cent. to 0.5 per cent. on the weight of ore),' a very wide range, with no statement or indication as to whether the 0.02 per cent. is preferable or the higher limit, twenty-five times as much, or what conditions are to determine the amount to be used."

As I said, he has forgotten the important statement on page 1, line 96, of the patent in suit:

"The minimum amount of oleic acid which can be used to effect the flotation of the mineral in the form of froth may be under 0.1 per cent. of the ore; but this proportion has been found suitable and economical."

708 And the complaint which Dr. Byrnes made is not justified by fact.

Dr. Byrnes states in paragraph 2 on page 168:

"From my study of the prior art, and from my tests of the processes disclosed therein, as well as of the process in suit, I am entirely unable to find any point of novelty in the process described and claimed in the patent in suit, so far as it is carried out by the use of the apparatus shown in Figure 1."

As Dr. Byrnes has given a summary of the essence, at least as he tries to interpret it, of the prior art, I will criticize that part of the above statement which refers to the prior art when I am considering this summary. But he limits his conclusions in this statement to the use of the apparatus shown in Figure 1. He has not used the apparatus described in the patent in suit and diagrammatically illustrated by Figure 1. He omitted that part of it which is essential to the process of the patent in suit. The patent tells you to agitate for the purpose of beating in air. That he has not done and his conclusions as drawn from the working of Figure 1 of the patent in suit are faulty.

The last paragraph of Dr. Byrnes' answer referred to, pages 173, 174 of Defendant's Record, states that the patent in suit is very vague as to the details of the process and as to the proportions of oil and acid to be employed. He says here again what he has also stated on page 180 of Defendant's Record, namely, that the
709 patent specifies the proportion of oil and acid,

"say from 0.02 per cent. to 0.5 per cent. on the weight of the ore,"

and continues later on—

"Later the description states, in the most general terms, that the proportion may be 'under 0.1 per cent. of the ore.'"

He omits deliberately to state the end of the sentence, closing the quoted part from the patent in suit (page 1, lines 100, 101):

"may be under 0.1 per cent. of the ore; but this proportion has been found suitable and economical."

This is a distinct statement and sufficient guidance for any metallurgist to work upon. It is impossible to be more accurate in a process which may be used for a large number and variety of different ores, and it is impossible to demand of a patentee that, for the purpose of his patent specification, he should try to collect all ores from the different parts of the world and describe a specific treatment for each of them, with specific proportions of all the ingredients for each of them. They give as an example the well-known Broken Hill ore, with which they appear to have been very familiar. They inform the world what they consider the limits of their proportions, and they add that in their experience 0.1 per cent. of oil of
710 the amount of ore has been found "suitable and economical."

Surely one cannot demand more, and even a metallurgist of very low qualifications cannot fail to determine with the greatest ease what quantities will give him the desired results. Dr. Byrnes then states that the amount of sulphuric acid or other acid or salt to be added may be any fraction under one per cent. or up to one per cent. This statement is again not a full statement of what is contained in the patent, because the patent says that the water should contain a fraction of one per cent. or up to one per cent. of a mineral acid or acid salt. I cannot find any reference to a salt, only acid salt. The reason for the addition of acid is stated plainly on page 1, lines 41-44:

"to prevent gangue from being coated with oily substance, or, in other words, to render the selective action of the oil more marked."

It is well known to any metallurgist, and it must have been well known to Dr. Byrnes that ores frequently contain small quantities of substances which absorb mineral acids and that therefore it was impossible for the patentees to fit all varieties of ore which are in existence with one coat. The object of the patentees is to have an acid reaction; that means, the faintest quantity of acid present during the process of oiling, and as long as a test paper, after having been wetted with the pulp, shows acid reaction, the condition of the patent is fulfilled. These are such simple tests that, if a stu-
711 dent after a few months' study was not capable to carry them out, he was sure to be severely censured. It is the easiest thing to find within five or ten minutes the quantity of acid which will answer the purpose of the patentees. Dr. Byrnes has a very low appreciation of the abilities of metallurgists.

As to the suitability of the different oily substances for the separation of minerals from ore, different types of oil and different oils of these different types have been frequently described prior to the application for the patent in suit, and were well known to people conversant with the art. Dr. Byrnes apparently expects, at least that is the only conclusion I can come to from these remarks on pages 173, 174, of Defendant's Record, that the patentees ought to have tried every oil in existence with every ore in existence and ascertained for every ore in existence the quantity of sulphuric acid which will leave faint acidity during the operation of the process of the patent in suit. Such a patent would fill a fairly large volume. Of course, the suggestion that every oil should have been tried by the patentees is absurd. The patentees give a fair warning, page 1, lines 61-69:

"The proportion of mineral which floats in the form of froth varies considerably with different ores and with different oily substances, and before utilizing the facts above mentioned in the
712 concentration of any particular ore, a simple preliminary test is necessary to determine which oily substance yields the proportion of froth or scum desired."

And the patentees describe specifically the use of oleic acid, thereby indicating which of the oily substances they found efficient. The number of oils which may be used is very large, and all that can be demanded of a patentee is to explain how one can determine by a simple test which of a large number of substances suitable for the purpose of a patent is the most suitable and economical. It is, of course, essential that the patentee should state which substance he found in his experiments the best, and the patentees of the patent in suit have done so.

Dr. Byrnes then complains that the agitator or mixing vessel shown is confessedly old with Cattermole and is relatively inefficient. The patent in suit does not claim any novelty for this apparatus. But I deny that this apparatus is inefficient, and I say it is only inefficient as used by Dr. Byrnes with parts of the apparatus omitted. If properly used it is an excellent apparatus for the purpose of the

patent, and it was also an excellent apparatus for the Cattermole process. The froth-separating apparatus I agree with Dr. Byrnes is, as shown in Figure 1, a very old device and I need not add that it is not claimed as a novelty in the patent in suit.

As to Dr. Byrnes' conclusions, I disagree with him, par-
713 ticularly with his statement that the patent in suit describes and claims no new process. In my opinion, the process disclosed in the patent and set out in the claims is a fundamentally new process, which involves a hitherto unknown phenomenon. I shall sum up the prior art later in my deposition.

Adjourned to Wednesday, November 6, 1912, at 10:30 in the forenoon, at the same place.

New York, November 6, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Direct examination continued:

38 Q. Have you had a reproduction made of the Froment apparatus, as described in the testimony, which was delivered by Alcide Froment to Mr. John Ballot and his associates during the latter part of the year 1903?

By Mr. Scott: The question is objected to as calling for secondary and hearsay evidence, in that it does not appear that the witness ever saw the apparatus in question or that he has any knowledge of its construction, in this connection it being noted that the record of this suit, upon which the witness will presumably base his answer, contains nothing but the most meagre references to the con-
714 struction, form and dimensions of the apparatus referred to.

A. I inquired, after having read the testimony and the description of Froment, for the apparatus which had been sent by Froment at the end of 1903, but I was informed that this apparatus had been destroyed long ago, as it had proved of no value and quite inefficient. I had, therefore, an apparatus constructed after consultation with the metallurgist of Minerals Separation, Ltd., Mr. A. Howard Higgins, who had used the apparatus. I did not have the whole of the apparatus made for the obvious reason that the screens had nothing to do with the question in issue. I had made the mixer and the vat with the coil. I now produce this apparatus.

By Mr. Williams: The deposition of the present witness is interrupted for the production of Mr. A. Howard Higgins as a witness to more fully identify the details of construction of the reproduced Froment apparatus just produced.

A. HOWARD HIGGINS, the witness produced in behalf of the complainants, having been duly cautioned and sworn, testifies as follows:

1 Q. Are you the same A. Howard Higgins who has heretofore testified in this suit, at the request of defendant's counsel, as a witness for defendant?

715 A. I am.

2 Q. I now show you the apparatus produced by Dr. Adolf Liebmann as a reproduction of the Froment apparatus received by Mr. John Ballot and his associates in the latter part of the year 1903, which original Froment apparatus you have testified was seen and used by you. Please state whether or not this apparatus is an accurate reproduction, as to details of construction, of such Froment mixer and such Froment vat with coil.

A. The apparatus is almost an exact copy of the original received, with one exception. The mixer vessel was possibly one or two inches less in diameter and had no covers. The agitating mechanism is, as far as I can remember, an exact copy, as is also the vat with coil containing the rake.

Direct examination closed.

Cross-examination.

By Mr. Scott:

3 X Q. Have you any recollection at this date regarding the relative number of teeth upon the different gears in the original Froment apparatus?

A. As far as I remember, they were about two to one.

4 X Q. Have you any recollection upon this point other than a general idea, that is, did you take any special note of this

716 relation when you had the original machine before you?

A. My idea that I am right in this answer is based upon the turbulence of the liquid when operating the machine, which seeems to be about the same as that in the original apparatus.

5 X Q. The two beaters of the original Froment machine have been described by a witness in this suit as "made of stout wire, somewhat like grid-irons." What parts of the apparatus produced by Dr. Liebmann embody this construction of beaters made of stout wire like grid-irons?

A. Possibly the elliptical frames carrying the horizontal arms.

6 X Q. By horizontal arms do you refer to the small pieces of angle iron screwed to the elliptical frames?

A. I do.

7 X Q. In operating the original Froment machine, did you make any observations as to the number of revolutions per minute imparted to the agitators which you can use as a basis of comparison with the speed of revolution of the stirrers in the apparatus produced by Dr. Liebmann?

A. I have no record of any observations on the speed of these beaters, but feel certain that they would be rotated at the highest

speed convenient, which I consider to be between 300 and 400 revolutions per minute.

8 X Q. Is it your recollection that the original Froment apparatus did have stirrers consisting of stout wire somewhat like grid-irons?

A. The apparatus produced by Dr. Liebmann is the em-
717 bodiment of the recollections I have of the Froment machine, which I may say are quite clear, the beaters being, as I have said, an exact reproduction.

9 X Q. It is not your recollection, then, that the beaters of the original Froment machine consisted of stout wire somewhat like a grid-iron?

A. No, I should not describe them that way.

10 X Q. At the time you saw the original Froment machine, did you make any comparison between that machine and any drawings of the Froment apparatus whereby you could now state more definitely than from pure memory as to whether the apparatus produced by Dr. Liebmann is like the original Froment apparatus?

A. I made no comparison of the apparatus with the drawing, and it is, therefore, only possible for me to say from memory that the apparatus is the same.

11 X Q. Did you see any drawing of the Froment apparatus at about the time you saw the original Froment machine?

A. No.

12 X Q. And I presume you made no drawing of the machine which you saw or any written notes describing it.

A. I have not found any.

13 X Q. Have you made any search for such notes or drawings?

A. I looked through my notes to see whether I had any information on this subject.

718 14 X Q. Did you look through all of the records to which you had access which might possibly have contained information upon the construction of the original Froment apparatus?

A. I looked through those only in my possession.

15 X Q. You mean in your personal possession?

A. I include as well those in my possession in my capacity as metallurgist to Minerals Separation, Ltd.

16 X Q. Did your search include all of the records of Minerals Separation, Ltd.?

A. No.

17 X Q. Were you instructed by Minerals Separation, Ltd., to make a search regarding the construction of the Froment machine through all of their records bearing upon that point, including such records as were made during and after the tests which were performed prior to the purchase of the Froment patent by Minerals Separation, Ltd., or by parties acting in the interest of the organization subsequently known as Minerals Separation, Ltd.?

A. I have no recollection of any such instructions.

18 X Q. At the time you saw the original Froment machine, did

you see any written description of the machine or of the mode of operating it?

A. No.

Cross-examination closed.

719 Redirect examination.

By Mr. Williams:

19 R. D. Q. Did you prepare for Dr. Adolf Liebmann a specimen of Broken Hill ore by desliming it?

A. I did.

20 R. D. Q. And was or was not such desliming in accordance with ordinary metallurgical practice?

A. On a laboratory scale, certainly.

21 R. D. Q. Exactly how did you deslime it?

A. The ore was placed in a bucket, a stream of water directed into the bucket so that when the same was full there was a constant overflow. During this period the ore was carefully stirred up in the bucket. By these means the slime was washed out. When the overflow water was almost clear, the operation was stopped, and the surplus water poured off.

22 R. D. Q. Was that the condition of this ore as to crushing before you deslimed it?

A. It had been crushed through a 60 mesh screen.

Redirect examination closed.

Deposition closed.

A. HOWARD HIGGINS.

720 Deposition of Dr. Adolf Liebmann resumed:

The apparatus produced by Dr. Liebmann as a reproduction of the Froment apparatus in the particulars stated is now offered in evidence and the mixer is marked "Complainants' Exhibit, Reproduction of Froment Mixer," and the other piece of apparatus is marked "Complainants' Exhibit, Reproduction of Vat with Coil."

Mr. Scott: The introduction in evidence of the exhibits referred to is objected to upon the ground that the evidence does not show that the exhibits are what they purport to be, namely, reproductions of apparatus sent by Froment to the complainants or their predecessors.

39 Q. Mr. Higgins has testified that he prepared for you a specimen of Broken Hill ore by desliming it. Please state what tests you made with this deslimed ore.

A. I performed yesterday, together with Prof. Chandler, who has been ill and who was only the first time capable to leave his house after his protracted illness, in the presence of counsel for complainants, the following experiments:

1. The ore which had been deslimed by Mr. Higgins was not quite dry. We, therefore, first analyzed what amount of moisture was left

in it. We found it contained 15% of water. We took a quantity of ore corresponding to 2½ kilos of dry ore and filled it into the Fro-
721 ment mixer. I should mention that the ore was Broken Hill ore. We then added 6 liters of water and 62½ grams of engine oil and agitated the mixture at a speed as near as possible of 300 revolutions per minute. I say as near as possible, because as this apparatus shows it is worked by hand and it is impossible to say for certain whether the speed was always the same. It might have been at times greater and at times perhaps slower. 50 grams of calcite had been added. The agitation lasted about fourteen minutes, but after ten minutes the agitation was stopped and the mixture examined. There was a thin film of oil on the top, extremely thin, and there was some air bubbles in it. The oiled ore was at the bottom of the mixer. It was examined also before it was emptied out and the same appearance was observed, namely, a thin film of oil with some air bubbles on the surface of the liquid and the oiled ore at the bottom. The mixture was then, whilst being agitated, emptied out into the vat provided with the coil, but only water ran out and the ore had to be washed out with water. When everything was contained in the vat provided with the coil, the rake contained therein was turned around at a speed of about ten to twelve revolutions per minute, and 143 cc. of diluted sulphuric acid, containing 35% of sulphuric acid, was poured in through the leaden pipe which ends in one of the perforated coils at the bottom of the vat. But no appreciable amount of minerals were carried to the top. I should say, scarcely any appeared. Although the depth of the ore was
722 such in the vat with the coil that the rake worked in it, the construction of the rake in my view is wrong and the rake is inefficient for the purpose it is intended for. It cuts grooves into the ore pulp and moves in the same grooves after they have once formed. The experiment proved only two facts: that the oil settles both in the mixer if the agitation is stopped and in the vat with the coil at the bottom, and that the only thing which appeared on the surface of the mixture is a thin film of oil.

I arrived at the conclusion that neither the construction of the agitator contained in the mixer is suitable and efficient, nor the construction of the rake contained in the vat with the coil. I, therefore, made an experiment, as follows:

2. A quantity of the deslimed ore, corresponding to 500 grams of dry ore, was filled into a cone mixer, 1200 cc. of water, 12½ grams (14 cc.) of engine oil, and 10 grams of calcite were added, and the mixture was agitated in the cone mixer for ten minutes at a speed of 300 revolutions per minute. After ten minutes' agitation, the apparatus was stopped and the mixture examined. There was, just as in the Froment mixer, a thin film of oil on the surface of the liquid. The oiled ore was at the bottom. The mixture was again agitated and, whilst being agitated, run out into a wide shallow vessel. The oiled ore was, as before, at the bottom of the vessel; film of oil, but no minerals on the surface of the liquid. The mixture was gently stirred by hand with a spatula and 30 cc. of diluted sul-

723 phuric acid containing 35% of sulphuric acid gradually added to it. A layer of oil with concentrates appeared on the surface. It was removed and further 30 cc. of the same acid added, the result being that more minerals appeared on the surface having the look of a magma; that is, of a pasty mass of oil and minerals enclosing some carbonic acid bubbles. The concentrates thus obtained looked very good, but the tailings were not quite clean. If the minerals and oil were allowed to remain on the surface, that is, not collected, they fell again to the bottom after a short time. As I stated, I worked at a speed of about 300 revolutions in the cone mixer. This speed is given in the instructions obtained from Froment as a proper speed. But as it is a speed for a larger vessel, I thought it fair to repeat the experiment with a much greater speed.

3. A quantity of the deslimed ore corresponding to 500 grams of dry ore (Broken Hill ore) was filled into a slide machine, 1200 cc. of water, 14 cc. of engine oil (12.5 grams, equal to 2½% on the ore), and 10 grams of calcite were added thereto and the mixture was agitated in the slide machine at a speed of 1600 revolutions per minute. The agitation was stopped after two minutes. A film of oil was on the surface of the liquid. The oiled ore was at the bottom. The result was identical with the result obtained either in the cone mixer or in the Froment mixer. The mixture was then slowly agitated at about twelve turns per minute. This was, of course, done by
724 hand, that is, by moving the belt driving the agitator by hand, whilst, at the same time, 30 cc. of dilute sulphuric acid (containing 35% of sulphuric acid) were gradually added. The concentrate rose in the form of a magma to the top. It was removed and had the appearance of a very good concentrate.

In these experiments I went out of my way to give the Froment instructions the best chance of success and, as is seen from the description of my experiments, I used apparatus in experiment 3 which was not available at the date when the Froment instructions were received. These experiments confirm that the process revealed by the Froment instructions can be carried on in a laboratory for the concentration of ore, but is of no use for an economical concentration today nor was it at the time when these instructions were received.

The ore which I used in these experiments was, as is stated, Broken Hill ore. It contained 17% of zinc and 6% of lead. The instructions of Froment direct the use of mineral engine oil. I used in these experiments mineral engine oil of the best quality known as Mobiloil, and which is a mineral oil. The instructions as to the quantities of oil to be used are as follows:

"If the ore contains more than five per cent. of metallic matter such as copper, lead, it will be necessary to add a little more oil. As a general rule, one may assume:

725 1% of oil for ore containing up to 5% of metals; 1½% of oil for ore containing up to 10% of meals; 2% of oil for ore containing up to 15% of meals."

As this ore contained 23% of metal, I used 2½% of the oil, which was also in the proportion of 50 lbs. of oil to the short ton of ore.

40 Q. Did you perform any other tests yesterday in the presence of Dr. Chandler and myself, and, if so, what did you do?

A. I performed the tests with Dr. Chandler which I had made before and which are described in my answer to 34 Q. as the test tube reproduction of Dr. Byrnes' alleged Froment experiments in the slide machine described in Defendant's Record, pages 165, 166. The results were exactly the same as I have described before. They did not produce the Froment result described in the patent, nor did they produce any separation of the values from the gangue.

41 Q. Please now give consideration to the summary of the prior art given by Dr. Byrnes, commencing at the middle of page 168 and ending at the middle of page 173 of Defendant's Record.

A. Dr. Byrnes makes his summary of the prior art under different headings. He first enumerates the patents in which he finds the disclosure of the preferential affinity of oils and fats for the metalliferous constituents of ore for graphite. Then he enumer-
726 ates the documents in which he finds a disclosure of the use of acid. Then he enumerates the documents in which the flotation of oiled minerals by attachment thereto of bubbles of air or gas is disclosed. Then he enumerates the agitators, which according to his tests may be used for entangling atmospheric air and beating it through a mixture. Then he states that widely different amounts of the same oiling agent have been used and finally he enumerates the patents in which heating of the oil or of the mixture of pulp and oil has been described. Dr. Byrnes' mode of making this summary of the prior art is very misleading and it is not a summary which can be used as a guidance to ascertain the true state of the art and what is revealed therein. It may be called an index of the contents of the different documents, but it is not a revelation of the processes used therein and of the facts produced thereby. An invention is not anticipated because some of the steps have been used before it was made to produce different results. If that were so, the progress of the world would be arrested and further inventions would be impossible. There are innumerable chemical inventions which use the same chemical substances, which use the same steps in producing a new result. I will give an illustration of what I mean. If you treat, for instance, napthol with sulphuric acid at 70° Centigrade, a new compound, a combination of napthol and sulphuric acid, is obtained. If the same napthol is treated with sulphuric acid at 20° Centigrade, the
727 result again is a combination of the napthol with the sulphuric acid. The latter compound, when submitted to certain chemical reactions, produces one of the most beautiful red colors in existence. The former compound does not yield, until the identical treatment, any color whatever. Another example of the variety of action is shown in cotton. If cotton be acted upon by dilute sulphuric acid containing as little as .025% of sulphuric acid, it is tender. If cotton is treated with dilute sulphuric acid containing about 50% of sulphuric acid, it is rendered white and lustrous, it is what is popularly called mercerized, and stronger than it was originally. The novelty in a patented invention is not destroyed because one or two steps had been known before. The novelty depends on the process as

a whole and on the novelty of the result produced, and it does not matter whether any of the steps or all of them had been used before for different purposes, and it does not matter whether some of them had been used in earlier attempts to achieve a similar object and had failed. That rather increases the value of the invention, because the former failures were a warning against renewed attempts.

Dr. Byrnes' first point is that he finds a clear disclosure of the preferential affinity of oils and fats for the metalliferous constituents of ore in several enumerated patents. As the patentees admit this in their specification of the patent in suit and specifically refer to
728 two of the patents which Dr. Byrnes enumerates, to wit, Cattermole, No. 777,273; and No. 777,274 (Spec., page 1, lines 16-27), Dr. Byrnes is merely stating what the patentees admit.

Dr. Byrnes' second point is that he finds a clear disclosure of the use of acid, for example, sulphuric acid, including small amounts of acid, in processes of oiling the metalliferous constituents of ore, with statements that acid increases the preferential affinity of oil for the metalliferous constituents, in certain enumerated patents. This is undoubtedly true and no point of novelty is made as to this in the specification of the patent in suit, and the same two patents which Dr. Byrnes includes under this point are specifically referred to in the patent in suit as above stated. As I have said, this was the invention of Carrie Everson.

Dr. Byrnes' third point is that the flotation of oiled minerals by the attachment thereto of films or bubbles of air or gas or by the adhesion of the oiled particles to bubbles of air or gas is disclosed in certain prior patents, which he enumerates. That is true of some of them, but it is not true of the Schwarz, Kirby and Froment patents. In these documents it is oil which includes minerals and gas bubbles and this mixture is floated.

Under this point he also says that he can use agitators of prior patents for the purpose of the patent in suit. Now that he has learned of the invention, this may be true. Probably there
729 are a great many more agitators in existence which can be used for the purpose of the process of the patent in suit, but the important fact is that none of them was used for that purpose. His reference to the Everson patent is altogether wrong. Everson describes no agitator at all, but only agitation sufficient to cause the mixture of mineral, oil, and acid, with oil in very considerable quantities, the oil and mineral being removed by a constant overflow well known at the time, and the operation being possible because the oil and mineral are lighter than the sand or gangue. None of the patents mentioned depends for its success on the beating in of air by means of an agitator. In some of the documents mentioned such agitation which would result in the beating in of air would be impossible; in others it would prevent the achievement of the result. I cannot pass over this paragraph without comment on the remarks which Dr. Byrnes makes about the Froment test tube examples (page 170). I utterly disagree with the following statement:

"In his (Froment's) test-tube experiment, agitation sufficient to coat the mineral particles with a thin film of the oiling agent also

thoroughly aerates the mixture, the fine bubbles of air distributed throughout it, and attaching themselves to the oiled particles, acting with the chemically evolved gas to float them."

There is not a word mentioned in the Froment patent about
730 aeration by atmospheric air and I further say that such aeration is utterly impossible according to the description which Froment gives of his test tube example.

Dr. Byrnes' fourth point that widely different amounts of the same oiling agent have been used is true, but it is not true that oils have been used under 1 per cent. or a fraction of 1 per cent. of the weight of ore, as stated by Dr. Byrnes on page 171. It is certainly not true that the phenomenon of the patent in suit, namely, the agitation froth, has either been produced with large or with small quantities of oil. The only document which discloses comparatively small quantities of oil, namely 4 to 6 per cent. on the minerals, is Cattermole, and he does it for the definite purpose of increasing the falling power of the minerals in order to be able to collect them at the bottom of the classifier.

Dr. Byrnes' fifth point is that the use of warm water or a warm mixture is an obvious and necessary expedient where oleic acid is used. That is not only not obvious but quite unnecessary for the purpose of oiling, as ordinary commercial oleic acid is a liquid at normal temperatures. The red oil used by defendant is an impure oleic acid, and, therefore, not as liquid as ordinary commercial oleic acid. According to my opinion, the increase of temperature plays a different part from that which Dr. Byrnes tries to explain at such
length on pages 171, 172 and 173. It is a well known
731 physical fact that the power of occluding gases, that means, the power of attracting gases, increases with the increase of temperature with metals, and the superior results which are obtained at the higher temperature I attribute to this well known physical fact.

From Dr. Byrnes' summary nobody can gather any information whether any of the alleged anticipations describes the process and the result, either identical or similar to the process or result of the patent in suit. Dr. Byrnes' summary is not a summary, but an index.

Adjourned to Thursday, November 7, 1912, at 10:30 in the forenoon, at the same place.

New York, November 7, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

42 Q. I now call your attention to the answer of Dr. Byrnes to Q. 15, appearing at pages 182-185 of Defendant's Record, and also the answer of Dr. Byrnes of X Q. 65 appearing at pages 213, 214 of Defendant's Record, the conclusion of the reasoning of these two answers appearing to be that the Cattermole granulation process is an oil-gas flotation process. What have you to say as to this testimony?

A. The answer of Dr. Byrnes first mentioned in your question, which is contained on pages 182-185, is again a proof
732 of the difficulty present in the minds of certain people that they cannot put themselves back to and form a correct opinion of the knowledge of an earlier time. They interpret always by the later standard. But even with this explanation, this answer of Dr. Byrnes is very surprising. An unbiased mind reading these two documents, namely, patents Nos. 777,274 and 788,247, which have been correctly called the soap patents, would know at once that they are intended for the use of the same quantity of oil as has been revealed in the Cattermole patent, No. 777,273, and that they use, instead of oil, soap, and produce the oil therefrom, as the patentees call it, in situ, which means in the mixture, by the addition of acid. No. 777,274 describes the recovery of the concentrates by granulation. No. 788,247 describes the recovery of the oiled particles by skin flotation and refers to any of the well-known methods for producing the effect of skin flotation. The expression,

"only seek to coat every particle of metalliferous matter as thinly and evenly as possible,"

occurring in an argument filed by the applicants for their patent No. 788,247, surely is quite clear and is only capable of one interpretation, namely, that the object of the patentees was to coat every particle of metalliferous matter as thinly and evenly as possibe, as was known at the time, and that was with the quantity of oil
733 used by Cattermole, and disclosed in patent No. 777,273, the difference being that, in the latter document, the oil was present as such in the mixture whilst in the former the oil was generated from soap. I will quote the paragraph of the argument in which the above quoted sentence appears:

"A very important line of distinction between Everson's process and the Applicants' is that Everson oils the whole of the ore and gangue initially as thoroughly as possible and seeks to wash the gangue out of the mass by acid water or the like. The Applicants on the other hand avoid any oiling of the gangue by wetting the whole first with water and by such preferential wetting and the mode of producing the oleic acid only the metalliferous matter present is coated. The Applicants never make a pasty mass of the whole ore, but only seek to coat every particle of metalliferous matter as thinly and evenly as possible and therefore to keep the gangue and the mineral particles from agglomerating together."

The argument was used to differentiate the process from Everson's earlier invention described in patent No. 348,157. Everson mixed the ore with oil first. In order to do this, she had to use considerable quantities of oil. When the mixture of oil and ore was then treated with water and acid, the gangue was cut out and there was a large quantity of oil in excess, in which the oiled mineral particles were embedded. In the process used in patent No. 788,247, the
734 oiling of the gangue did not occur, and therefore there was no excess of oil present in which the oiled particles would

unite together. The coating with oil can only of course refer to the coating with such quantities as were known at the time, and the lowest quantities used known at the time were the quantities of Cattermole. Everson used for making the paste 18% of oil of the amount of ore to be treated. It is in evidence that the Cattermole process was tried mainly for Broken Hill ore, which contains about 25% of minerals. Cattermole, Sulman and Picard only oiled the values and not the gangue, and they would require only 6% of oil if they were to produce the same effect as Everson did with 18% of oil. As a matter of fact, Cattermole found 4 to 6 per cent. of oil a suitable quantity in proportion to the mineral in the ore, or 1.4 to 2 per cent. of oil in proportion to the ore with which they mainly experimented. I repeat that the statement, coated as thinly as possible, can only refer to the coating of minerals as was known at the time and not to the coating of minerals which was discovered long after, and disclosed in the patent in suit.

There is a wide difference between the coating with oil as disclosed in patents No. 788,147 and No. 777,274, and the coating with oil as disclosed in the patent in suit, and it is quite apparent from the quantities which are described as useful in the two different sets of patents. In the Cattermole patents No. 788,247 and No.
735 777,274, the quantity is clearly alike with the quantity disclosed in Cattermole patent No. 777,273, and that is 4 to 6 per cent. on the minerals, (1.4 to 2 per cent. on the ore), with a warning that the process is not to be used with lean ores. In the patent in suit the quantity found suitable is .1 per cent. Expressed in pounds per short ton, Cattermole requires 28 to 40 lbs. as a useful quantity, and the patent in suit describes 2 lbs. as a useful quantity. Furthermore, it is a necessity for the Cattermole invention that the oiled particles can be granulated and rendered specifically heavy, heavier than the gangue. In other words, they must have a greater falling power than the gangue, so much greater that the gangue can be removed by an upcast, or an upward flow of water, whilst the granules are not removed thereby. The Cattermole granules have an oily look, no luster, no light is reflected therefrom. The oiled particles of the patent in suit appear as a froth on the surface of the liquid. They are brilliant, metallic looking substances, no oil can be discerned on them, and it is impossible to obtain granulation from them. There is no overlapping possible in these two patents. Cattermole warns you against the use of lean ore. If you want to treat lean ore, add granules to it, which have already been formed, or other matter having affinity for oil, or pulverized mineral matter which had been obtained from an ore. It is clear that he has in his mind as a suitable ore for his treatment Broken Hill ore. The patent in suit discloses as a suitable and economical amount .1 per cent.
736 of oil. It is true that the patentees do not limit themselves to this quantity, but that is the quantity which, on careful reading of the specification, would suggest itself to a metallurgist.

As to Dr. Byrnes' answer to X Q. 65, I disagree with the same. I say that the Everson process depends on the reduction of the specific gravity of the minerals by oil and the sinking of the minerals is pre-

vented by an upcast. Glogner and Good are oil buoyancy flotations. Patent No. 788,247, a soap patent, results in skin flotation, and the same is true of No. 793,808 to Sulman and Picard. Patents No. 807,501 and No. 807,503 to Schwarz depend on oil buoyancy flotation assisted by gas, and the same is true of No. 809,959 and No. 876,626 to Kirby. British letters patent No. 12,778 of 1902 to Froment depends on oil flotation assisted by gas produced in a nascent state.

I disagree absolutely with the long argument contained on page 214, in which Dr. Byrnes tries to show that Cattermole is an oil-gas flotation process. Cattermole does not disclose anything but the formation of heavy granules, so heavy that they remain at the bottom of the liquid even after the introduction of an upcurrent of sufficient force to carry the gangue away.

It is again an attempt to alter the character of an earlier invention by the introduction of later processes and later investigations. It is particularly unfortunate and uncalled for with the Cattermole patent, which is a brilliant invention, clearly written and well defined both as to process and to result.

737

43 Q. Will you please now give a summary of the patents referred to in the deposition of Dr. Byrnes?

A. The patents referred to by Dr. Byrnes in his deposition may be roughly divided into three classes, namely:

1. Apparatus.
2. Processes for ore treatment by means of water.
3. Processes for ore treatment by means of oil.

Apparatus.

The patents disclosing the invention of apparatus and the literature quoted as disclosing an apparatus are:

Wagner, No. 373,113;

Stoveken, No. 729,805;

Extracts from Treatise on Chemistry applied to Manufacture of Soap and Candles.

Wagner discloses a churn by which he alleges he can produce lactic acid by the action of the oxygen of air on sugar. It has been introduced apparently for the purpose to show that it was known that air could be introduced into a mixture by agitation, and that a chemical action could be produced thereby, and that in this way casein could be coagulated and separated from the butter when the butter globules are ruptured by agitation. Such an apparatus would not stand up under the severe conditions of agitating a gritty ore pulp.

738

Stoveken describes an apparatus for the extraction of precious metals, and more especially gold, from ores of low grades. It is an agitator destined to bring air into the mixing of the ore with a weak cyanide solution, in order to effect a rapid and complete solution of the gold and silver contained in the ore by providing the oxygen necessary for the chemical action. It has no reference whatever to the concentration of ores by means of oil.

The extract from the Treatise on Chemistry applied to the manufacture of Soap and Candles has no reference to ore concentration. It is intended to fill a liquid soap with air bubbles so that its specific gravity is reduced, and that it can float on water.

I submit that there is nothing disclosed in these documents which could shed any light on ore concentration by means of oil, and I further submit that there is nothing contained in these documents disclosing the process of the patent in suit.

2. Processes for Ore Treatment by Means of Water.

The following patents fall under this heading:

Bradford	No. 345,951;
Hockley	" 466,753;
Rouse	" 469,599;
Hebron & Everson	" 471,174;
Delprat	" 735,071;
Delprat	" 768,035;
Potter	" 776,145.

739 Bradford's invention consists in processes for saving materials floating on water and to collect losses occurring on Rittinger tables, Frue vanners, and jigs. An ore, when immersed in water, will produce with part of the minerals skin flotation, and Bradford's invention was to collect these minerals floating as skin flotation. There is no oil used whatever and the economy which is effected is due to the well-known phenomenon of skin flotation, and no slimes can be treated with it.

Hockley discloses an apparatus to save the float mineral, usually called slimes and sometimes flour gold and silver, by surface tension flotation. He assists to produce this flotation by means of an upcurrent, which may be air, water or steam. When the particles arrive on the surface, they will float on exposure to air. It is a simple surface tension phenomenon and no oil is used to produce it.

Rouse discloses a process for the saving of slimes from water used in grinding ores. This water contains sometimes valuable minerals and Rouse saves it by bubbling air into the water. The principle is the same as in Hockley. He uses an upcurrent rapid enough to prevent the descent of the slime water. He does not use oil.

Hebron and Everson disclose an attempt to reduce the specific gravity of minerals by attaching to them substances of much lower specific gravity. It is not quite clear whether the patentees thought
740 that their flotation was due to specific gravity. The process, in my opinion, is a surface tension flotation process. No oil is used.

Delprat in his two specifications describes the carrying of minerals to the surface of water by means of gas bubbles generated in the mixture. The gas bubbles attach themselves to the mineral and lift it to the surface. No oil is used.

Potter is like Delprat, a flotation of minerals by gas bubbles generated in the mixture, no oil being used.

3. Processes for Ore Treatment by Means of Oil.

Under this heading I shall treat the patents in four sub-headings, as follows:

(*a*) Oil and ore mixed, and mixture treated with acidulated water;

(*b*) Pulp treated with oil; concentrates separated from surface;

(*c*) Pulp treated with oil; concentrates separated from bottom of liquid;

(*d*) Pulp treated with oil; concentrates floated by introduction of gases through pipes or generation of gases in the mixture.

Under the sub-heading (*a*) I include the following patents:

Everson ..... No. 348,157;
Schwarz ..... " 807,501;
Schwarz ..... " 807,503.

741 Under the sub-heading (*b*) I include the following patents:

Elmore ..... No. 676,679;
Elmore ..... " 689,070;
Glogner ..... " 736,381;
Good ..... " 745,960;
Kendall ..... " 771,075.

Under the sub-heading (*c*) I include the following patents:

Cattermole ..... No. 777,273;
Cattermole, Sulman & Picard ..... " 777,274.

Under the sub-heading (*d*) I include the following patents:

Froment ..... No. 12,778 of 1902;
Sulman & Picard ..... " 793,808;
Cattermole, Sulman & Picard ..... " 788,247;
Kirby ..... " 809,959;
Kirby ..... " 838,626.

(*a*) Oil and ore mixed and mixture treated with acidulated water.

Everson discloses two processes in her patent. According to the first, she produces a stiff mass by mixing the ore with a compound prepared by mixing a small quantity of sulphuric acid with cotton seed oil. The dough-like mass is then kneaded in water, by which operation the gangue is removed. It is not a practical pro-
742 cess and has never been used. The quantity of oil which she advises is in proportion of about 6 grams of oil to 112 grams of ore (over 5 per cent.), which is 100 lbs. of oil to the ton of ore, and which is altogether prohibitive.

Everson's second process depends on the reduction of the specific gravity of the ore by such quantities of oil and to such an extent

that the mixture of mineral, and oil is lighter than the gangue, and on the separation of such a mixture of mineral and oil by an up-current of water. She mixes the pulp with a quantity of oil amounting to 18% of the ore, or 360 lbs. of oil to the ton of ore. The process is out of question on account of its high cost, even if the process would work. No froth is produced and no satisfactory separation of values from the gangue can be obtained by this process according to my experiments made in strict accordance with this Everson patent.

Of the Schwarz patents, the first one states as the object of the invention the conversion of valuable oxides or carbonates into sulphides and adds the description of an oil separation process for the recovery of sulphides thus obtained by means of oil. The separation process of sulphide minerals from the gangue is more fully described in the second patent. Schwarz makes first a paste of his ore and oil (the oil is a mixture of two different oils in certain quantities, which at ordinary temperatures is solid), and then blows air or gas through pipes into this paste. To be able to do this, he must at least use a quantity of 50% of oil, or 1,000 lbs. to the ton
743 of ore; otherwise, he could not blow the air in and keep the mixture of ore and oil in the vessel. Such a paste is pretty thick and he could only use slow agitation with it. He then mixes water with it and continues the blowing in through pipes of air or gas to assist in the distribution of the water throughout the paste and to effect the thorough washing out of the tailings. Schwarz' recovery is due to oil buoyancy flotation assisted by the enclosure of air bubbles in the oil. Some of his oil is recovered by a centrifugal drum or filter press. The process is far too expensive to be of practical value.

(*b*) Pulp treated with oil; concentrates separated from surface.

The two Elmore patents depend on oil buoyancy flotation pure and simple, and they differ from each other that in the one no acid is present, whilst in the other one an acid is present. Only heavy oils are used. The extraction of the ore with oil is repeated so often until the tailings are clean. The quantity of oil used in these processes is roughly three tons of oil to one ton of ore treated, assuming an ore such as Broken Hill ore is treated. A large quantity of this oil is recovered by centrifugal separation. It appears from the testimony that this process was practically used to some extent, but abandoned long ago.

Adjourned to Friday, November 8, 1912, at 10.30 in the forenoon, at the same place.

744 New York, November 8, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Direct examination continued:

Answer to 43 Q. continued: The Glogner patent describes a process for purifying graphite from its natural mineral impurities.

The heavier impurities have to be removed first before the material is submitted to treatment. It is then mixed with three or four times the quantity of water and petroleum is added in a quantity amounting to one-half the quantity of pure graphite contained in the ore. The mixture is contained in a suspended vessel, which is moved like a pendulum by hand at a speed of 30 shocks per minute, which movement induces the sunken mass to turn over and to come into contact with the petroleum. After settling, the petroleum, which contains part of the graphite, is removed and the operation is repeated once, twice or more, each time after the addition of fresh petroleum, until the graphite has all been separated from the mixture. The process results in the removal of the graphite by buoyancy oil flotation.

Good's invention refers to an apparatus for separating graphite or other materials from associated impurities. He does not say what the other materials are and describes the use of his apparatus only for graphite. He makes the separation in three steps: (*a*) by
745 surface tension flotation on water without the use of oil; (*b*) by oil buoyancy flotation; (*c*) by preferential grinding of the graphite in a mixture of coarse graphite and sand and separation of the so ground graphite from the sand by a screen. There are no details whatever given of the oil flotation. It is clear from the construction of the tank that it can only be used for oil buoyancy flotation, and, furthermore, that the agitator in the tank can only be used for very slow agitation. Nothing is contained in this document which has any bearing on the patent in suit and, even with the knowledge of today, the apparatus described could not be used to produce the effect of the patent in suit. It is a patent only for an apparatus.

Kendall describes another process for the separation of graphite from graphite ores or graphite waste by means of kerosene or paraffin oil, which by reason of its levity carries the graphite to the surface. It is an oil buoyancy flotation process.

(*c*) Pulp treated with oil; concentrates separated from bottom of liquid.

Cattermole, No. 777,273, Granulation, and Cattermole, Sulman and Picard, No. 777,274, Soap and Granulation, mark a distinct step in advance. They leave the old path of trying to effect the separation of the values from the gangue by reason of a reduced specific gravity of the mixture of oil and mineral. They choose the opposite way. They increased the size of the fine particles by agglomerating a number of them together, the oil with which they were coated
746 forming the cement or agglomerant. And in this way they obtained granules of such a size that the law which governs specific gravity and the true falling power in a liquid was established. The values settled on the bottom of a classifier and the gangue, much lighter than the values, was removed by the force of an upcurrent. The well known cone mixer was used for the agglomeration of the oiled particles by agitation, followed by a rolling form of agitation if necessary, the latter to be performed in cylinders or the like. The patentee (Cattermole) warns against the use of lean ores, and the

same warning must apply also to Cattermole, Sulman and Picard process, as the only difference between these two patents is that in the latter the oil is generated in the pulp. The quantity of oil recommended is from 4 to 6 per cent. of the amount of mineral present in the ore (1.4 to 2 per cent. on Broken Hill ore), but the amount to be used depends on the sort of granules which are desired as well as on the ore which is to be treated. I have found for defendant's ore that a suitable proportion for this Cattermole process, using oleic acid, was from 6 to 7 per cent. on the mineral, which amounts to from 1.8 to 2.1 per cent. on the ore, and have obtained good granules with these proportions, which are in evidence. The step forward marked by this invention was that for the first time the concentrates sank to the bottom of the vessel and that the gangue was floated off. The quantity of oil required, if the quantity recommended by Cattermole is used, is from 28 to 40 lbs. per ton of ore for Broken Hill ore. The quantity which I found suitable for defendant's ore is from 36 to 42 lbs. per ton of ore. I refer to the short ton, unless I state otherwise.

747

(d) Pulp treated with oil; concentrates floated by introduction of gases through pipes or generation of gases in the mixture.

Froment describes some principle embodying the following phenomena:

1. Natural sulphides moistened by oil have a tendency to unite in spherules and to float on the surface.

2. This tendency is retarded by the specific weight and opposed by the gangue in which the moistened sulphides are embedded.

3. The bubbles of a gas generated in this mass become covered with an envelope of sulphides and rise to the surface as a kind of metallic magma.

4. The formation of these spherules is particularly active if the gas used is in a nascent state.

There is no process described in this patent—only a test tube experiment, from which, however, two important factors can be obtained, namely, the quantity of gas which he wants to generate in a nascent state, and the minimum quantity of oil which he intends to use. He advises the use of 10 per cent. of calcite of the quantity of ore used, which will provide him with 5 per cent. of carbonic acid, and the use of a thin layer of oil which must be at least, according to my actual tests, 12½% of the amount of ore used. The result is obtained instantaneously. Froment was manager of an Elmore concentration plant, and it is clear from the introduction that his invention is a modification of the Elmore process. The result is obtained by oil buoyancy flotation assisted by gas bubbles enclosed therein. Froment describes his float as a magma. Ure's Dictionary of Arts, Manufactures and Mines, gives the following definition of this word:

748

"Magma is the generic name of any crude mixture of mineral or organic matters, in a thin, pasty state."

This definition is substantially repeated in Murray's and Webster's International Dictionaries, referring to Ure.

The quantity of oil used in the test tube experiment corresponds as a minimum to 250 lbs. to the ton of ore.

Cattermole, Sulman and Picard, No. 788,247, Soap and Flotation patent, depends on the Cattermole process for oiling the minerals and generally refers to known processes for flotation of the oiled minerals. The quantities of oil used are the same as in the Cattermole patent as a minimum. The phenomenon is skin flotation.

Sulman and Picard, No. 793,808, which has been referred to as the Bubbles patent. This is another skin-flotation process, the skin flotation being produced by a number of apparatus. The
749 quantity of oil must be such that it will moisten the mineral particles; but should be less than is required for buoyancy flotation by the oil alone.

The two Kirby patents disclose an apparatus and a process for separating the minerals from the gangue by an oil buoyancy flotation assisted by air blown in through pipes at the bottom of the apparatus. This process is an improvement on Elmore, thin oils being used, which oils can be recovered from the concentrates completely by filtration and by distillation of the concentrates. The quantities of oil specified as giving excellent results are 500 to 1,500 lbs. of oil per ton of ore.

In none of these alleged anticipations is the phenomenon or the process of the patent in suit disclosed. In none of these alleged anticipations is there any suggestion which would lead anybody towards the process or the phenomenon of the patent in suit. In none of these alleged anticipations is there any suggestion that by beating in air a froth could be produced consisting of air bubbles densely covered with minerals and carrying practically, the whole mineral contents of the ore. In none of these alleged anticipations is there any suggestion that a quantity of oil could be used so small that it disappeared and could only be detected on the concentrates, by chemical methods.

I repeat that the patent in suit discloses an absolutely novel and unexpected phenomenon, and an absolutely novel discovery which no one could have foreseen.

750 44 Q. Please now include in your summary the patents and publications which were not referred to by Dr. Byrnes.

A. The patents and publications which have been referred to in this evidence, but not by Dr. Byrnes, are as follows:

1. Apparatus.

The Wolf patent, No. 787,814, discloses an agitator which has been described in the testimony as the Johnson agitator. This agitator is shown at the upper left-hand corner of the drawing. It works in substantially the same way as a cone mixer. Instead of a revolving cone, we have a stationary hollow cylinder supported by radial arms, which act as baffles. A revolving stirrer is located below this hollow cylinder.

2. Processes for Ore Treatment by Means of Water.

The Hebron patent, No. 474,829, is an improvement on the Hebron and Everson patent, No. 471,174. No oil is used. The ore is prepared by heating or vacuum to drive out the air, and to enlarge the holes or pores alleged to be present in the minerals, and a buoy stock is pressed together with the ore and is supposed to attach itself to the mineral. The mineral containing the buoy stock is separated from the gangue by flotation, according to the statement of the patent. This is the last patent in the Everson series
751 and marks the final and complete abandonment of the use of oil to effect separation.

3. Processes for Ore Treatment by Means of Oil.

The Haynes British patent, No. 488 of 1860, contains the first disclosure of the use of oil for ore concentration. The ore is mixed with oil to form a stiff paste, which is then kneaded with water to wash out the gangue. It is not a practical process.

The Fryer Hill publication of 1889 is clearly a further development of the Everson patent. It adds to Everson the use of heat. The specific agitator which is described as having arasta-like fans probably ought to be arrastre-like fans and is derived from the Spanish word "arrastre," which means to drag. The process so far as it can be determined from this publication is open to all the objections of the Everson process as described in the Everson patent.

The Crifey-Everson publication of 1890 is a modification of the Everson process as described in the Everson patent, black thick oil being used instead of petroleum, and water near boiling being used. The experiment appears to have been made in a laboratory. There is a clear disclosure of the use of acid in small quantities as in the Everson patent. No practical process of ore separation is disclosed in this scant description.

The Robson patent No. 575,669, which appears to have
752 been partly assigned to Crowder, is for a process which has been referred to in this evidence as the Robson and Crowder process and in this process the ore is moistened with water and then a stream of oil is used to wash out the mineral. On the face of it, it is clear that this process is far too wasteful and expensive to be of any use.

The Cattermole patent No. 763,260 is known as the Emulsion patent and discloses the use of an oil emulsion in the granulation process of patent No. 777,273. The solution is alkaline instead of acid. This is a division of the application on which patent No. 777,273 was granted, and is clearly a variation of the Cattermole process, giving the same proportions of oil as are given in the Cattermole patent No. 777,273.

The other Cattermole patent mentioned by me, No. 763,259, is for the classification or separation of concentrates or granules ob-

tained by the Cattermole process, that is, the separation of the different sulphides from each other. This is effected by retreatment of the granules in an apparatus substantially the same as is disclosed in the other two Cattermole patents with the use of a breaking down solution. This process starts with oiled granules, and is not a process for the separation or concentration of the values contained in an ore.

I can only repeat here what I said at the end of my preceding answer. These patents and publications do not disclose or suggest the invention disclosed in the patent in suit. They give
753 further examples of the efforts to solve the problem of ore concentration by oil and of the failure to do so in a practical and economical manner.

45 Q. I call your attention to the testimony of Dr. Byrnes in answer to Q. 24, appearing on pages 193-196 of Defendant's Record. What have you to say as to this testimony?

A. I have carefully read the testimony given by Mr. Edward H. Nutter, which he gave with regard to the sample of froth which he collected from defendant's plant whilst it was in operation. I quote the passage contained on page 23 of Complainants' Record:

"The concentrates froth from *f* and *g*, the frothing boxes of the smaller unit, were flowing into the launder D, and the sample of froth which I took was from the lip of the frothing box *f* as it flowed into the launder D."

Mr. Nutter also testified that this smaller unit was a retreatment unit, and in this he was right, as defendant's witnesses admit. I cannot understand the assertion of Dr. Byrnes that Mr. Nutter pretended to have taken a handful of froth from an alleged sixth frothing box, which did not exist. It is perfectly clear to me that Mr. Nutter testified that he took his sample from the first frothing box of the second unit, which he properly described as the retreatment unit.

754 As to Dr. Byrnes' remarks that the conclusions which Prof. Chandler drew from his very exact experiments are based on pure speculation, I must frankly confess that I cannot follow the bent of his mind which led him to say this. Dr. Chandler made an analysis by a recognized method, which cannot be improved upon, and drew his conclusions from the results which he obtained. He confirmed the correctness of his conclusions by a series of well conceived experiments which could not be improved upon, and I accept his results as facts, as everyone who knows the great reputation of Prof. Chandler, both here and abroad, will do.

46 Q. Have you read the depositions of Edward H. Nutter, Jesse C. Gibson and James M. Hyde, and the descriptions therein of the apparatus referred to by defendant's witnesses as defendant's experimental plant, from which apparatus Mr. Nutter testified that he took a sample of froth while the apparatus was in operation, and do you understand the construction and operation of said apparatus?

A. Yes.

47 Q. Could this apparatus be used for any of the processes of the patents and publications referred to by you, except the agitation froth process disclosed in the patent in suit, so as to produce a floating

froth in the spitzkasten of the type described by Mr. Nutter in his deposition?

A. No.

755 48 Q. Assuming that powdered ore, water acidified with sulphuric acid, and oleic acid are fed into the defendant's apparatus referred to and that a floating froth of the type described by Mr. Nutter appeared on the spitzkasten, what have you to say as to the process being carried out under such conditions in defendant's apparatus?

A. I say that a froth thus produced must have been produced by the process of the patent in suit.

Adjourned to Saturday, November 9, 1912, at 10:30 in the forenoon, at the same place.

New York, November 9, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Direct examination continued:

49 Q. As I understand it, you have read all of the deposition of Dr. Byrnes in behalf of defendant and are therefore familiar with that part of this deposition wherein defendant's second plant is described?

A. Yes.

50 Q. I now repeat Qs. 47 and 48 as applicable to defendant's second plant described by Dr. Byrnes.

A. My answers are the same as to those questions.

51 Q. What have you to say as to the suggestion that the retreatment of concentrates and of the residues obtained from the

756 retreatment of concentrates, constitute, either separately or collectively, a departure from or an improvement on the agitation-froth process as set forth in the patent in suit?

A. The retreatment of the concentrates and of the residues obtained from the retreatment of the concentrates does neither constitute a departure from nor is an improvement of the agitation-froth process as set forth in the patent in suit. It is a mere repetition of the process carried on with material containing different quantities of mineral and gangue.

52 Q. I particularly call your attention to Qs. 48-50 and the answers thereto in the deposition of the defendant, James M. Hyde, pages 71 and 72 of Defendant's Record. What have you to say as to this testimony?

A. Qs. 48-50 speak of an odor of sulphuretted hydrogen. I have noted this odor to a very slight extent in my tests of defendant's ore. This odor is not due to the decomposition of the valuable sulphides, but to some other sulphide, probably an iron sulphide which is present in the ore and quite valueless. There is not a trace of the valuable sulphides attacked by the dilute acid present in the pulp mixture. Some suggestion has been made in the evidence that sulphuretted hydrogen or hydrogen sulphide might be used like car-

lonic acid in statu nascendi, that is, in the nascent state, as a suitable gas for carrying oiled minerals to the surface. That is not so. Sulphuretted hydrogen is comparatively soluble in water, but
757 that might be overcome. The reason why sulphuretted hydrogen cannot be used for this purpose is that it is dangerous to human life. It is one of the most dangerous poisons in existence and I know of several cases in which the leakage, and that a very small one, from a closed vessel caused the loss of human life. To use this gas for the concentration of ores would, if it were done, soon put an end to the concentration process. The very trifling quantities that can be produced in defendant's plants may be unpleasant to the smell, but it is impossible that they contribute in any way to the process of ore concentration. There can only be the very faintest traces of this gas, otherwise it would have a bad effect on the workmen, and from this ore and under these conditions only the very faintest traces of this gas can be produced. Such very faint traces are appreciable to the smell. That is all.

53 Q. I now particularly call your attention to Q. 8 and the answer thereto in the deposition of Dr. Byrnes, pages 178, 179 of Defendant's Record. What have you to say as to this testimony?

A. The answer of Dr. Byrnes is very much involved and difficult to understand for the ordinary mind. It has been a well established fact, since the time of Everson's discovery, that the presence of acid in a mixture of pulp, and oil cuts the gangue out, and it has been well known that the presence of acid in a mixture of pulp and oil prevents the oiling of the gangue, and that is the purpose for
758 which the acid is present. If an ore contains calcite, which is an easily decomposable carbonate, then the amount of acid must be larger than if there was no calcite present, in order to enable the sulphuric acid to fulfill its mission, namely, to prevent the gangue from being oiled. In defendant's ore rhodochrosite, or manganese carbonate, is present to a slight extent, and I have proved experimentally that it is at lower temperatures not readily attacked by dilute sulphuric acid. But if the whole quantity of sulphuric acid which defendant uses would act and produce carbonic acid, there is so much water present during the transit of the mixture of ore and water to the pulp thickener that it would merely pass into solution or into the air. It could not remain in contact with the enormous excess of water without being dissolved, and it would certainly be dissolved during the agitation process later on. This is also true as to sulphuretted hydrogen, if any traces of it should be formed, and, as I have said, nothing but the merest traces of it could appear in defendant's plants.

I am convinced, from my analyses of the gaseous content of the agitation froth, that air is the agent which forms the froth, and that the presence or absence of small quantities of other gases has no effect whatever in the production of the froth, while the consumption of sulphuric acid, which would produce these bases, is a serious detriment to the economy of the process.

54 Q. I now particularly call your attention to the last
759 paragraph of the answer of Dr. Byrnes to Q. 11, pages 180, 181, of Defendant's Record. What have you to say as to this statement?

A. I say that this statement has no significance whatsoever. I always understood that a patent was addressed to persons conversant with the particular art with which it deals. Metallurgists know that ores are not individuals, but mixtures. Metallurgists know that an ore may contain small quantities of an acid-absorbing substance. It would be impossible for any patentee to give definite amounts of acid in a patented process dealing with a large variety of ores. He can only state for what purpose the acid is present and it is for the metallurgist to obey the instructions of the patentee and to see that there is acid present whilst he performs the process of the patent, and to see that the acid is not consumed by secondary reactions. If the secondary reactions cannot be avoided, more acid must be used, so that there may be free acid to perform the function which the patentees wish it to perform, if it is to be used.

55 Q. It is suggested in the deposition of the defendant that the word "powdered," as used in the patent in suit, means "dry" ore. What have you to say as to this suggestion?

A. Amongst technical men if a substance is to be powdered, that is, finely crushed, it is usually done with water, if water has no influence on the substance; that is, neither destroys it, nor dis-
760 solves it. It is much easier to crush with water than without water. Powdering means reducing to a fine state of division, and it does not matter whether it is done dry or wet.

56 Q. The defendant has put in evidence a patent granted to him on April 2, 1912, No. 1,022,085. What have you to say as to this patent?

A. I say that this patent contains a description of the process disclosed in the patent in suit.

The patentee calls first attention to the fact that certain metallic and non-metallic elements differ from each other in their behavior to oils and fats, that the metallic substances are coated thereby, and that they can be separated from the gangue by markedly different surface tension phenomena.

The patentee then states that many ores containing a number of mineral components show, when crushed, that the resulting pulverized material consists of particles which are so fine and of such a colloidal nature that they settle very slowly and interfere with obtaining a high-grade concentrate by the use of a flotation process. The patentee says he has discovered that this settling is greatly promoted by the introduction of a small amount of sulphuric acid, with or without some salts, to a pulp whilst in transit to the flotation device, and he enumerates the advantages which he obtains by this treatment, namely, the partial or complete coagulation of the slimes, which makes the thickening of a pulp possible in the pulp thickener, greater facility in separating the concentrates from the gan-
761 gue, cleaning of the surface of the particles of the floatable minerals and assisting, by the generation of minute bubbles

of gas in the pulp and on the surface of the floatable mineral particles, in the desired separation of the minerals from the gangue. The next sentence is a little bit difficult to understand and the conclusion more so, but the assertion is made that by the addition of the acid to the pulp before it reaches the flotation plant a smaller amount of acid may be used.

"as little as one quarter of a pound of crude acid per ton of ore treated" (page 1, lines 77-79).

A further discovery is announced that the concentrates produced can be retreated with the same process, without in certain cases the use of additional acid or coating agent. The oils suitable for the process are the oils which have been used in former oil ore-separation processes.

The plant shown is substantially the same as in the Hoover patent, No. 953,746, which appears on its face to have been issued to Minerals Separation, Ltd., one of the complainants, except that in the drawing only one agitating box is shown for each spitzkasten, whereas in the Hoover drawing three agitation boxes are shown for one spitzkasten, but the Hyde specification says that

"each of the agitator tanks may, if necessary, consist of a plurality of connected compartments, each provided with an agitator."

762 This suggested modification makes the plants the same, except that the deflector K of the Hoover drawings is omitted, and except also that the Hoover apparatus is repeated so that there are three units in the rougher or first treatment apparatus, and two units in the cleaner or retreatment apparatus.

In the agitator the mixture of pulp and oil is agitated and flows from there through an opening at the bottom into the spitzkasten, in which the froth rises to the top whilst the tailings collect at the bottom and are removed from there by a pump into the next agitator, where they are re-agitated and the treatment is repeated. The froth which rises to the surface of the spitzkasten flows into a launder and from there through a pipe into the first agitator of the cleaner or retreatment apparatus. The froths which form on the second and third spitzkasten of the rougher system, flow also into the first agitator of the cleaner system, and the operation is repeated in this system exactly as in the rougher system, with this distinction that there are only two agitators and two spitzkasten. The froth is collected from there and is ready for the smelter, and the tailings, which are called middlings, are pumped from the bottom of the last spitzkasten into the first agitator of the rougher system to pass again through the treatment of concentration.

The two alleged novelties are treatment of the pulp with sulphuric acid before it reaches the flotation plant and retreatment of the concentrates.

763 As to the first, namely, the settling of slimes and preparation of the pulp by treatment with sulphuric acid, this is described in Richards' Ore Dressing, a standard work in metallurgy,

and appears in Volume II, Section 869, pages 1147, 1148, which on the title page is stated to have been published in New York and London in 1905. I quote the following which is given as a test of the use of sulphuric acid for the purpose of settling an ore pulp:

"Time of settling, ½ hour; sulphuric acid 0.15 per cent. 100; sulphuric acid 0.29 per cent. 96; sulphuric acid, 0.57 per cent. 99."

I have taken these figures from the table and the numbers 100, 96 and 99, respectively, represent the percentages of total slimes settled out during this period of one-half hour with the respective proportions of sulphuric acid stated. This shows that a very small percentage of sulphuric acid gives the best results.

A metallurgist, wishing to thicken his pulp and to save his slime, would add his acid before the pulp goes into the pulp thickener or dewaterer, and that is just what the patentee Hyde has done.

An advantage claimed by the patentee Hyde for the addition of sulphuric acid before the pulp is mixed with oil is

"the cleaning of the surface of the particles of the floatable minerals"

764 before they are submitted to the oiling treatment. I call attention to the British patent No. 17,328 of 1906, granted to Minerals Separation, Ltd., as a communication from George A. Chapman. This patent specifically refers to the British patent for the agitation-froth process, No. 7,803 of 1905, corresponding to the patent in suit, and describes as an improvement upon it that better results are obtained if the pulp is first agitated with acidified water and the treatment with oil postponed to the second or later agitator.

Another advantage claimed by the patentee Hyde for the addition of sulphuric acid before the pulp is mixed with oil, is that minute bubbles of gas are generated in the pulp and on the surface of the floatable mineral particles, which bubbles assist in the desired separation of the mineral components of the ore. This statement is not in accordance with fact. The quantity of gas which can be generated by the quantity of suphuric acid stated as being used is so small that it could be ever so often dissolved by the quantity of water present, and what is not dissolved will escape into the air.

The other alleged novelty of the Hyde patent is the retreatment of the concentrates by the same process by which the original ore was treated. There is no novelty in this. It is a characteristic of the agitation-froth process that the quantity of oil is so minute and so firmly attached to the metallic particles that they can be agitated over and over again without removal of the invisible oil films on the particles. Re-agitation of a dirty concentrate is simply re-
765 agitation of an ore pulp which is richer than the original ore pulp, and return of the residue or middlings from the agitation of such a dirty concentrate is simply good metallurgical practice if anything can be gained by it, and it is the ordinary practice in any well conducted factory.

57 Q. Please now briefly describe patent No. 979,857 issued to

Minerals Separation, Ltd., as the assignee of Theodore J. Hoover, on December 27, 1910.

A. This patent discloses an apparatus for carrying on the process of patent in suit, and shows a combination of agitators and spitzkasten with six agitators and three spitzkasten arranged in very nearly the same relation as in Defendant's Experimental Machine, the only difference in arrangement being that each spitzkasten has two agitators in series instead of the successive spitzkasten having three, two and one agitator, respectively.

Direct examination closed.

Adjourned to Monday, November 11, 1912, at 10:30 in the forenoon, at the same place.

New York, November 11, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Mr. Williams: An offer is now made to repeat in the presence of defendant and his counsel any of the tests or experiments
766 testified to by the witness, this offer to be availed of at any time during the cross-examination.

It is stipulated that Volume II of Richards' Ore Dressing, referred to by the witness, was published and circulated during the year 1905. Sec. 869, appearing on pages 1147 and 1148, of Richards' Ore Dressing, the book referred to, is offered in evidence to be replaced by a copy thereof, marked "Complainants' Exhibit, Extract from Richards' Ore Dressing," and the entire book is handed to defendant's counsel for use in cross-examination.

Cross-examination.

By Mr. Scott:

58 X Q. Referring to that paragraph of your answer to Q. 34 beginning with the words "I took 10 grams of defendant's ore, which had been crushed in my presence to 80 mesh, mixed it with 30 cc. of water." I ask you to state to what you attribute the failure of the operation described in that paragraph to produce a froth containing the sulphide ore particles.

A. That experiment was not performed with the intention of producing a froth. That experiment was performed with a view of finding out whether the quantities which Dr. Byrnes had used were such quantities as would come under the Froment patent, and whether the Froment result namely, a magma, could be obtained. I was convinced that it could not be obtained, and the result proved that I was correct.

767 59 X Q. In the paragraph above referred to, you state that "practically all the ore was at the bottom, some slimes and oil, which could be observed by its glistening, at the top."

Does not this condition of affairs indicate that the agitation had been insufficient, either in degree or duration, to distribute the oil, thereby causing it to adhere to the sulphide particles?

A. No. It only shows that there was an insufficiency of oil to carry out the Froment test tube experiment. I have stated that I found experimentally that 12½ per cent. would be the least amount which could be used according to the Froment description and instructions in the patent.

60 X Q. If, in the experiment described in the paragraph above referred to, you had increased the degree or the duration, or both, of the agitation, would the amount of oil used have coated the sulphide particles and have caused the formation of a floating mass containing the sulphides or a considerable part of them?

A. If, instead of using the instructions of Froment, I had used the knowledge of today, and the directions of the patent in suit, I might have got a float, as you say. I have never performed this experiment in a test tube and cannot say with absolute certainty what the result would have been.

61 X Q. In the experiment described in the paragraph above referred to, did you agitate the mixture contained in the test tube as violently as you conveniently could by manipulating the
768 test tube by hand; for instance, did you shake it as violently as you would a medicine bottle which is labelled "Shake well before using?"

A. Much more than that, although there is no call in the Froment patent for such agitation. The Froment patent and the test tube example contained therein call for such agitation as would be necessary to bring the sulphuric acid in contact with the limestone, and, as there is a large excess of limestone, the very simplest shaking will effect that result, and if it is not carefully done, the reaction will be as violent as the patentee has described. The contents of the test tube are ejected from it by the sudden evolution of carbonic acid.

62 X Q. In the experiment described in the paragraph above referred to, you operated with defendant's ore. In operating upon that ore in the manner described in that experiment, have you found the evolution of carbon dioxide to be so rapid, violent and great in amount as to make it necessary to restrain the degree of agitation which you impart to the mixture in the test tube?

A. I pressed the lower end of the thumb on the test tube and shook first for two seconds what one may call violently. Then I made an observation and after that shook again for six to eight seconds. The amount of carbonic acid which could have been evolved was so small that it would have been dissolved in the water which was present. It requires only 17 cc. of water for solution. From experimental experience I have grave doubts whether any carbonic acid was evolved at all.

769 63 X Q. Then, in performing the experiment described in the paragraph above referred to of your answer to Q. 34, it was not the fear of an excessive generation of carbon dioxide that caused you to limit the period of agitation to two seconds and to an additional six or eight seconds. Am I right in this?

A. No. I did not limit the time of agitation. According to my reading of the Froment patent, I extended the time. If the Froment quantities are taken, as described, two seconds is ample time to see the phenomenon which he has described. It is an instantaneous reaction.

64 X Q. Are the proportions of the different substances used in the test tube experiment, which you describe in the paragraph above referred to in your answer to Q. 34, such proportions as you would be induced to use by a reading of the patent in suit?

A. These proportions are within the patent in suit.

65 X Q. These proportions being within the patent in suit, do you adhere to your statement made in your answer to X Q. 60 that you cannot say with absolute certainty what the result would have been had you followed the directions of the patent in suit?

A. Yes, for the following reasons. The patentees say, the quantities of oil found suitable and economical are .1 per cent. The quantity used was .3 per cent. The patentees say, one cannot give proportions for every ore, but a simple experiment will teach all that is required. I had not made that simple experiment and the answer which I gave is correct.

770 66 X Q. Is the reaction between sulphuric acid of the strength resulting from mixing a few drops of sulphuric acid with 30 grams of water and a carbonate always instantaneous, regardless of the character of the carbonate, that is, regardless of what base enters into the carbonate, regardless of the condition of the carbonate as to its state of crystallization, or whether it is a precipitated carbonate? I may also add to this inquiry whether the quickness of the reaction is not also related to the temperature?

A. No. The difference, for instance, of crystalline structure and amorphous structure makes a difference in the evolution of the gas. For instance, if you use precipitated carbonate of lime or marble, there is a difference in evolution. The difference between different carbonates is also marked. For instance, limestone in finely powdered condition is much more readily attacked than crystallized manganese carbonate. Heat nearly always favors chemical action. Then there is another important factor, whether the acid is used in more concentrated or more dilute form. There are numbers of instances known in chemistry in which acid of a certain dilution fails to produce a result, which in more concentrated form is easily produced. Froment was fully aware of this difference in the behavior of carbonates.

67 X Q. And any metallurgist or chemist, even of comparatively low qualifications, would be aware of the different behavior of different carbonates under the different conditions to which you

771 have referred in your preceding answer, would he not?

A. Quite so, and that is the reason why Froment advises the addition of limestone to the ore.

68 X Q. I understand, therefore, that your statement in answer to X Q. 63, embodied in the words "it is an instantaneous reaction," is not a statement of universal application, but merely refers to the fact that, when a proper carbonate in a proper condition is selected,

and the proper acid in its proper condition of dilution is selected, and when the temperature is adjusted at the proper point, a practically instantaneous reaction may result. Is my understanding of your answer correct?

A. My answer to X Q. 63 is quite clear:

"If the Froment quantities are taken, as described, two seconds is ample time to see the phenomenon which he has described."

It clearly refers to limestone. Other carbonates may result in instantaneous action if the proper conditions can be found.

69 X Q. Do you find anything in the British Froment patent to indicate to the metallurgist that an instantaneous reaction would take place between sulphuric acid of the dilution used by you in the experiment described in the paragraph of your answer to Q. 34 above referred to, and the kind of carbonate contained in the ore used by you in that experiment?

772 A. I find from the British Froment patent that the quantity of acid used in this experiment would be absolutely useless for the production of the Froment result, namely, the production of metallic spherules to form a magma clearly separated from the rest of the liquid.

70 X Q. The amount of acid necessary to react with a given quantity of carbonate involves only elementary knowledge, does it not, and is something that would be obvious to any chemist or metallurgist, even one of comparatively slight qualifications?

A. Yes, the amount of acid is determined by the amount of carbonate which is to be decomposed. That is knowledge which every beginner ought to have.

71 X Q. And if, in following the directions of the Froment British patent, the operator were to use some carbonate that did not readily react with the acid employeed, it would be obvious to him, would it not, that he should adjust the temperature and other conditions to the point favorable to such reaction?

A. No, that is not at all obvious. If it were only the intention to produce carbonic acid, then such adjustment would be permissible. But if it is only an incident in a different and novel process, which depends or may depend on other conditions and reactions, then such a proceeding would not be obvious.

72 X Q. If the operator, in carrying out the process described in the Froment British patent according to the directions therein contained, found that there was no reaction or a very slight

773 reaction between the acid and carbonate, these being present in the proper proportions, would it not be obvious to him, if he desired to promote the evolution of carbonic acid, to apply heat to the mixture upon the presumption that the temperature was too low?

A. That is not the way I look upon such a proceeding. In my view, the obvious thing to do would be to add the limestone as prescribed by the patentee. That seems to me the only fair way of carrying out the instructions contained in an example of a patent, unless the patentee directs you to do differently.

73 X Q. In dealing with this subject of temperature, do you intend

to convey the idea that the metallurgist, in carrying out the process of the Froment patent, is not, according to your idea, expected to utilize his elementary knowledge of the art, including his knowledge of the elementary principle that the reaction between many substances, including that between a mineral acid and a carbonate, is in many instances dependent upon the temperature of the reagents?

A. The metallurgist is, in my view, not entitled to use heat in a process such as the Froment process. There are physical phenomena involved in this process to which heat might be detrimental. As I said, if it were a process simply for the production of carbonic acid, that would be a different matter, but it is not so. The very fact that Froment describes the addition of limestone is sufficient for metallurgists to see how he wants the process carried out. There is
774 no earthly reason why a metallurgist should deviate from the prescription.

74 X Q. Do you consider the evolution of carbon dioxide so unimportant a detail of the process of the Froment British patent that the metallurgist would not be expected to utilize his elementary knowledge to an extent sufficient to adjust the temperature and other conditions to that point where carbon dioxide would be evolved, as directed by the patentee?

A. The generation of carbon dioxide is the important factor which enables Froment to carry out his invention, but the real process begins only with the utilization of the carbonic acid produced, and the question of temperature might have a very serious effect on the result. I repeat that, in my view, no metallurgist should deviate from the process as described. I consider the evolution of carbonic acid as directed by Froment as an important factor in the Froment process.

75 X Q. The evolution of carbon dioxide being an important factor in your view of the Froment process, would it not be the obvious thing for the metallurgist to adjust the temperature and other conditions to the point where this important factor would be present?

A. No, it would not be an obvious thing to do. The obvious thing clearly is to carry out the process as described by an inventor.

76 X Q. It is in evidence that the pulp in some localities has a temperature only two or three degrees above freezing. Is it your
775 idea that a competent metallurgist would apply the Froment process to a mixture such as described in this patent, utilizing water only a degree or two above freezing, and, under other circumstances, in a locality where the available water was of a high temperature in precisely the same way and without utilizing his knowledge that temperature has an important effect upon the reaction necessary to produce carbon dioxide?

A. The temperatures which the patentee intends to use are normal temperatures, such as they occur in places where operations of this kind are usually carried out.

77 X Q. What temperature is this normal temperature which you refer to?

A. Such temperature may vary within certain limits, but I believe

that the usual temperatures are somewhere about 15° to 16° Centigrade (59° to 61° Fahrenheit); it may be a few degrees up or down.

78 X Q. Then is it your understanding of the Froment British patent that the metallurgist, attempting to carry out that process, would be justified in considering the process a failure unless he secured the necessary evolution of carbon dioxide at the particular temperatures which you have named, namely 59° to 61° Fahrenheit?

A. My reading of the Froment specification is, that the process should be carried out at normal temperatures. I cannot quite understand the question. If you mean to ask me whether the fail-
776 ure of the process might be due to a variation of the temperature which had been used, then I cannot answer the question, as I have no experimental experience about it. If you mean to ask me whether such failure might be injurious to the validity of the patent, that would be a question for the courts. I am sorry to be a little dull today.

79 X Q. Suppose a metallurgist attempted to carry out the process of the Froment British patent, the mixture being at the temperatures of 59 to 61 degrees Fahrenheit; suppose that under these circumstances there was no perceptible evolution of carbon dioxide, notwithstanding the use of the proper amount of acid and carbonates; is it your belief as an expert that the metallurgist of ordinary intelligence would be led to the belief that the process was a failure and inoperative, and that this metallurgist of ordinary qualifications could not be expected to adjust the temperature to a point where the knowledge of his profession would tell him that an evolution of carbon dioxide would take place?

A. I cannot make this assumption. We have to deal with facts, with chemical facts which cannot fail and which always must give the result described by the patentee.

80 X Q. It is well known, is it not, that these chemical facts to which you refer do not give any result unless the conditions be so adjusted as to bring them about?

A. No. It is well known that, in following the Froment
777 instructions in the patent, you cannot help arriving at the result described. These facts are elementary knowledge and were known to Froment. There is no necessity for altering the conditions.

81 X Q. Do you find anything in the Froment patent to the effect that this process is to be carried out at a temperature of 59 to 61 degrees Fahrenheit?

A. Yes, most decidedly so. The very absence of instructions means that the process is to be carried out at ordinary temperatures, and the very addition of limestone, which so readily decomposes at ordinary temperature, is further proof of it. If heat were applied in this case, the result would be what he warns against.

82 X Q. If the metallurgist in carrying out the process of the Froment British patent, happened to be in a locality where the available water was of a temperature only three or four degrees above freezing, and the available carbonate was one not easily attacked by a mineral acid at that low temperature, is it your opinion as an expert

in this art that the metallurgist would be departing from Froment's instructions if he were to heat the water to a point where his elementary knowledge informed him that the carbon dioxide, which you say is an important factor of the Froment process, would be evolved?

A. As to the last part of the question, I believe I said that carbonic acid is, in so far as it helps to carry out the real process of Froment, an important factor, but this process, as I have stated before,
778 is not a process for the production of carbonic acid. The production of the carbonic acid is one step of several to carry out the invention. At to the other part of the question, I repeat that Froment must have had a reason for advising specifically the use of calcium carbonate (limestone), and I repeat that a metallurgist ought not to deviate from these instructions.

83 X Q. Is it your opinion that a metallurgist, reading the Froment British patent, would derive therefrom the idea that the process was applicable only when limestone was used, as distinguished from some other carbonate or some other mode of generating carbonic acid gas?

A. I gather from the description of the Froment patent, that the patentee intends the use of limestone, and he describes the use of limestone only wherever any definite instructions are given.

84 X Q. Would you, as an expert in this art, understand the Froment patent as indicating that the use of limestone as distinguished from any other carbonate is essential to the carrying out of his process?

A. It has always been my habit, in the reading of patents, to follow the instructions of the patentee, because he is the most competent person to say what his invention consists of. I will say, however, that if any chemist or metallurgist should find a carbonate which would work like limestone under the proper conditions, that is, at the temperature of the process of the patent, at the rate of
779 evolution of gas which can be obtained from limestone, such a carbonate might be used; but no metallurgist would be entitled to change these conditions. Limestone is, however, so cheap and it is to be found so frequently that there is no necessity for such additional research work.

85 X Q. From your answer I understand that, if the carbonate selected by you did not generate carbon dioxide at a temperature of approximately 59 to 61 degrees Fahrenheit, at the same rate that carbon dioxide is generated from calcium carbonate at that temperature, you would consider yourself outside of the instructions of the Froment patent in using such other carbonate. Is this correct?

A. I have stated that the directions of the patentee are to use the normal temperature and that he must have had reasons for giving them. It is a well known fact, especially with regard to ore concentration by means of oil, that the temperature is of importance, and it was especially known to Froment, who was manager at Traversella Mine, where the Elmore process was worked. In the Elmore process, heat is fatal to the result. The question whether anyone is outside the patent if he deviates from its instructions, is for

the Court. As a conscientious person, to work the Froment patent I should follow the instructions of the patent.

86 X Q. I asked you the preceding question and ask you this one for the purpose of ascertaining what a metallurgist would learn from the Froment British patent, taken by itself, and without in-
780 terpretation based upon documents other than the patent itself. I ask you for no opinion upon the legal effect of the patent, but a statement as to the information it conveys to a technical man independent of any experience which you say Mr. Froment may have had, but which was not set forth in the British patent. I ask you, therefore, whether, upon reading the Froment British patent and attempting to carry out the process there set forth, you would consider that you had exhausted the resources of an ordinary metallurgist by applying Froment's directions, as set forth in his test tube experiment, without adjusting the temperature to the point at which carbon dioxide would be evolved, and whether you would consider that you were in your trial of the Froment process, confined to the use of limestone.

A. I say deliberately that any change of temperature would, in my view, be unjustified. I see no reason whatever for deviating from the use of limestone, and I should certainly only work with limestone. I am aware that according to the requirements of the English patent law, the best example how to carry out an invention has to be given, and as this is the only example contained in the patent, I should follow its instructions implicitly.

87 X Q. I take it from your answer that you believe the information to be derived from the Froment patent by a metallurgist is confined to the use of limestone as a source of generating carbon di-
oxide, and that this patent would not teach a metallurgist
781 that other sources of carbon dioxide might be used or that other gases than carbon dioxides might be used. Am I correct in this?

A. I have stated in my direct evidence that this patent is rather a complicated document. It consists of a theoretical speculation and contains as a description of the process a test tube example. From the theoretical speculation, one may infer an absolutely different process, but there is no such process described anywhere, and the only help which a metallurgist gets from it is the test tube example. I will avoid another question and say, that in that part of the patent which I have called theoretical speculation, it is stated that:

"If a gas of any kind is liberated in this mass, the bubbles of the gas become covered with an envelope of sulphides and thus rise readily to the surface of the liquid where they form a kind of metallic magma,"

that might imply the use of other gases, but I know of no other gas which could be liberated in this mass except carbonic acid and sulphuretted hydrogen, and the latter is quite out of the question. I repeat, that, with the exception of the test tube example, we find only theoretical speculation in this document.

88 X Q. My question was directed to ascertain, in the first place, whether you believe the information to be derived from the Froment patent by a metallurgist is confined to the use of limestone
782 as to source of carbon dioxide in case carbon dioxide is to be used. Will you kindly answer that question?

A. Ido.

89 X Q. Referring to the experiments performed by Dr. Byrnes, numbered 3, 4 and 5, and described upon pages 158 and 159 of Defendant's printed record, you have stated, in your answer to Q. 34, as follows:

"I disagree with the result described, which I could not obtain."

Will you describe what operation you performed which resulted in failure to secure the results described by Dr. Byrnes, namely, the production of a froth?

A. Dr. Byrnes' experiments 3, 4 and 5 are represented as experiments of the Froment patent. I disagree with this description. They are not experiments of the Froment patent. In experiment 3, he mixes the Black Rock ore with water. In experiment 4, he adds sulphuric acid to the mixture of ore and water and heats the mixture; that is, he removes the agent which is essential to the Froment process, namely, carbonic acid in the nascent state. Then he waits until the Potter and Delprat result which occurred, namely, the appearance of mineral on the surface of the liquid, has disappeared and the mineral has again returned to the bottom, then he adds one drop of olive oil to the mixture and agitates. He then states that he obtained the magma or froth as described in the Froment patent. That is utterly impossible, for the following
783 reasons: Froment describes ordinary temperature, he describes the formation of a magma by the use of carbonic acid in the nascent state, he describes a layer of oil to be used, and Dr. Byrnes has not followed one of the instructions. I repeat that he could not have produced the Froment magma and that he did not produce it, and, finally, I say that aeration, as Dr. Byrnes describes it, is absolutely foreign to the Froment patent.

When I performed such an experiment, I did not obtain the Froment magma, but the agitation froth of the patent in suit, and the result was not due to carbonic acid, but to a prolonged, vigorous agitation.

90 X Q. Did this agitation froth which you secured contain bubbles of gas covered with an envelope of sulphides?

A. This agitation froth contained bubbles of gas covered with an envelope of sulphides, and it differed in this respect from the magma obtained according to the Froment test tube example. It was perfectly stable, the minerals were brilliant and had a metallic lustre. When it once appeared on the surface, it stayed, and when sunk by force, it could be re-obtained by vigorous agitation. The Froment magma is more like an oily layer containing bubbles of carbonic acid, which are enclosed in oil, in which the minerals are embedded. The magma is not lasting. In the agitation froth, no oil can be

discovered. If it is put on blotting paper, it dries, but it retains its shape. If the Froment magma is put on blotting paper, the
784 oil soaks into the blotting paper and leaves a large spot, and the bubbles collapse. In the agitation froth, the film enclosing the air is water, which is protected and strengthened by a dense layer of the minerals. In the magma there is a layer of oil, which contains carbonic acid bubbles, and the film enclosing them is oil covered with minerals. The difference between the two is that the agitation froth is lasting, whilst the bubbles contained in the magma are not.

91 X Q. On what observation or experiments, if any, do you base your statement that, in the practice of the Froment process, as you interpret that process, the carbonic acid bubbles are enclosed by oil, while in what you term the agitation-froth process the films of the bubbles are composed of water?

A. I base it on my personal observations.

92 X Q. In the operations which you have so observed, how much oil and what kind of oil did you use?

A. I remember having used oleic acid and cotton seed oil, but I am almost sure that I have used a number of other oils. In the Froment process I have used the thinnest layer which could form in a proper test tube, namely 12½ per cent. of oil to the amount of ore used.

93 X Q. How by observation are you enabled to determine whether the film of a bubble which is covered with an envelope of sulphides is formed of water or of oil?

785 A. That is comparatively quite easy with Froment, and Froment himself, in what he calls his principles, teaches you how to do it. If you mix your ore, limestone and oil and water together, the oiled minerals fall to the bottom. If you then add sulphuric acid, you can observe how the gas slips into the oil and how, in this way, the bodies are formed which are justly characterized by Froment, as spherules, little spheres. In the agitation-froth process, oil seems to be absolutely absent and it can only be discovered by chemical analysis. The films, therefore, must be water films.

94 X Q. Will you state at what point in the operation described in that paragraph of the Froment patent immediately below the paragraph numbered "4" the oiled minerals fall to the bottom of the test tube, in your answer taking into consideration Froment's statement that

"the whole of the copperpyrite will instantly rise to the top of the liquid."

A. The test tube example is clearly described as resulting from the principles laid down in the four paragraphs preceding it. It begins,

"Thus, for example."

I have carried out both the suggestions which are laid down in the four principles, and the process of the test tube example. The result is identical. There is no operation described in the test tube

example saying that the oiled minerals fall to the bottom.
786 The reaction proceeds so quickly and is so instantaneous that such a phase cannot be observed.

95 X Q. The matters set forth in the paragraphs of the Froment patent numbered 1, 2, 3 and 4 are introduced by the patentees's statement that the following phenomena studied by him have served as the basis of the process which forms the subject of his invention. Would you not, from this statement, understand that the four numbered paragraphs are merely statements descriptive of certain phenomena as distinguished from a description of a method of procedure, and would you not understand that the paragraphs following the four numbered paragraphs are a statement of practical procedure?

A. I should understand from the statement of the four principles which you have mentioned, and the beginning of the example "Thus, for example," that the patentee wishes you to understand that these are the actual facts underlying the test tube example.

96 X Q. Do you find in the Froment British patent any description of a method of carrying out his process, that is, a description of any series of practical operations other than that contained in the paragraph following the four numbered paragraphs?

A. To be quite frank, I do not find any practical process in the Froment document. There are the four principles which would suggest working in a number of steps. Then there is again a suggestion at the end of example 2, from which one can infer
787 that he might mean the process to be in a sequence of steps. And then there is the claim, which again claims only a sequence of steps. Yet, there is no description of any process containing or being based on a sequence of steps. The only process I find is a test tube example, and that is not a practical process.

97 X Q. In any of your work, have you succeeded in accomplishing the result described by Froment as taking place in the test tube experiment of the British patent, namely, the flotation of the whole of the metalliferous mineral, copperpyrite in the instance cited by Froment?

A. That I cannot tell. I never succeeded in removing the magma in such manner that the whole was removed without some of it falling back. I never made an assay of the tailing, as it would not have given me any information. I often wondered how Froment arrived at the result.

98 X Q. In your experiments following Froment's description of his test tube operation set forth in the British patent, were you able to form some idea by observation as to whether you succeeded in separating a substantial part of the metalliferous minerals by flotation?

A. I have no doubt that a substantial part of the minerals was obtained on the surface, but I should not like to say or guess how much it was. The magma was not lasting and part began to fall, one might say, at the moment of its birth.

788 99 X Q. What do you consider a layer of oil found on the top of water in a test tube—sufficient oil to cover the entire

meniscus and to contact with the walls of the test tube, or an amount covering the main body of water in the test tube?

A. In my view, there cannot be two definitions of a layer. A layer of oil is an amount of oil which will cover the surface of the water. Otherwise, it would be called a blob or a gobule. There are not two definitions possible.

100 X Q. Do you find that Froment, in his British patent, anywhere states that the layer of oil must cover the entire surface of the water in the test tube?

A. There was no description necessary; the language is quite intelligible. Apparently it did not matter to Froment whether more oil should be used, because he does not call it the thinnest layer, but a thin layer. I used nearly always the minimum quantity, namely, the thinnest layer of oil.

101 X Q. In your operations conducted along the lines of Froment's test tube operation, using 12½ per cent. of oil of the ore, did you obtain the result described in the third numbered paragraph of the Froment patent, namely, bubbles of gas covered with an envelope of sulphides?

A. Always, with the exception of once or twice when the contents of the test tube were blown out. There was always a layer of oil with the Froment spherules embedded in it. Froment calls the bubbles of gas covered with an envelope of sulphides, metallic spherules.

789 102 X Q. Is it or is it not a fact that different quantities of different oils are necessary to spread over the surface of water in the test tube to form such a layer as you have defined, namely, one extending to the walls of the test tube?

A. I was struck with the idea which you expressed in your question, and I always believe that actual experiments are the best answer. I tested the quantity of different oils required to form the minimum layer, and there is scarcely any difference between oleic acid and ordinary thin lubricating oil or a heavier lubricating oil, the latter requiring slightly more oil.

Adjourned to Tuesday, November 12, 1912, at 10:30 in the forenoon at the same place.

New York, November 12, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination continued:

Answer to 102 X Q. continued: I have looked up my notes and I find that with a very thin mineral oil, 8 per cent. are required to form the thinnest layer.

103 X Q. In reply to X Q. 58, you stated that the experiment described by you in the paragraph of your answer to Q. 34 there referred to was not performed with the intention of producing a froth.

What difference in procedure would you have followed in
790 performing that experiment if it had been your intention to produce a froth?

A. It is correct that this experiment was not performed with the intention of producing a froth. If I should have wanted to produce a froth, by which I assume you mean an agitation-froth, I should have taken larger quantities of ore, the proper quantities of oil and I would have shaken in a stoppered-up bottle. It is scarcely possible to produce an agitation-froth in a test tube, as a test tube almost always breaks. Then my usual practice was to give the bottle at least a hundred shakes and if no froth had appeared then, I would have continued shaking for fifty times more, and would have made another observation. That is the way I usually carry out experiments which were intended to result in an agitation-froth.

104 X Q. In performing the experiment above referred to, this being the experiment described in the paragraph in your answer to Q. 34 beginning with the words "I took 10 grams of defendant's ore which had been crushed," etc., did you place a stopper in the test tube?

A. I have described fully how I did it. I put the lower end of my thumb on the opening of the test tube and closed it up.

105 X Q. Then there was no stopper in the test tube other than the closure formed by your hand?

A. That was the only proper stopper to use, according to
791 the Froment description. Froment says that sometimes the contents are ejected from the test tube. That can only mean such closing up or warning not to have a stopper on and do it in the way I described, and I may add it is the ordinary way, that these experiments are always carried out in a laboratory. No other stopper than my thumb was used.

106 X Q. To state the matter simply, I understand that you did not use a stopper in the test tube because Froment did not mention a stopper and because you feared, in view of Froment's warning, as you term it, that it might have been dangerous to use a stopper. Is this correct?

A. I used my thumb because that is the usual way one does such tests, and it is the only convenient way to gradually reduce certain gas pressure without detriment to the experimenter. I did not expect Froment to describe a stopper. I only knew from the warning that we might expect a certain gas pressure.

107 X Q. In performing the experiment referred to, did you give the test tube as many as a hundred shakes?

A. No.

108 X Q. Is the quantity of ore mentioned and the quantity of oil mentioned as used by you in the experiment referred to, and the relation between these quantities, not adapted to the production of a froth?

A. The quantity of oil in proportion to the ore is about .3 per cent. as used in this test tube experiment, and that falls within the agitation-froth quantities.

792 109 X Q. In your answer to Q. 34, you refer to the second example described by Dr. Byrnes in the last paragraph of page 165 of Defendant's Record, and state that you reduced the quantities used by Dr. Byrnes to a basis of 10 grams of ore, tried the operation in a test tube, with the result that practically all the ore was at the bottom of the liquid and some oil containing some slimes on the top, the agitation employed by you being described as during two periods, one of two seconds and one of five seconds. In performing this operation, did you put a stopper in the test tube?

A. No.

110 X Q. Did you give the test tube as many as one hundred shakes?

A. No.

111 X Q. Was the violence of the agitation given to the test tube during the seven seconds referred to by you as great as that employed by you when it is your intention to produce a froth, as set forth by you in answer to X Q. 103?

A. I should say it was about the same, but it is difficult to form a correct opinion. My experiments concerning the production of agitation-froth were never carried out with less than 50 grams of ore, and this could never have been done in a test tube.

112 X Q. In any of your investigations of this subject did you agitate in a test tube the substances mentioned by you in your test tube repetition of Dr. Byrnes' experiment described in the paragraph beginning near the bottom of page 165 of Defendant's Record

793 for a period longer than seven seconds?

A. In none of my experiments referring to the Froment patent, or to questions arising out of the Froment patent, did I shake for a longer period than I mentioned, and in each case, where I followed out the Froment directions, I obtained the result within two seconds.

113 X Q. By "the result," I presume you refer to having all the ore at the bottom of the liquid and some oil containing slimes on the top, this being the result you have described as being obtained in the operation under discussion.

By Mr. Williams: The question is objected to as stating an assumption not warranted by the testimony of the witness.

A. The assumption of counsel that I have considered these experiments as Froment experiments is not correct, and I regret that my description of them and the reasons which induced me to make such experiments have been such as to mislead counsel. To avoid a further misunderstanding, I will now speak out in such language that such a misunderstanding cannot occur again. I consider the experiments of Dr. Byrnes, of which these test tube tests are the translation into the quantities of the test tube example, as utterly absurd and not at all representing anything which Froment described or which could arise out of the Froment description.

794 It has always been my habit in such cases to treat the opinions of experts on the opposite side with courtesy, and I have always refrained from sharp criticism. I am sorry that this

habit of mine, which I cannot alter at my present age any more, should have produced such a misleading impression in counsel. I repeat that the experiments introduced by Dr. Byrnes have nothing to do with the Froment patent. The result which I obtained when operating according to the Froment instructions was not what is stated in the question, but a magma clearly separated from the rest of the liquid.

114 X Q. I call your attention to the fact that, my question numbered 112 X Q., which started the present line of inquiry, made no reference whatever to the Froment process. That question was an inquiry as to whether you had in your repetition of Dr. Byrnes' experiment in question in any case agitated for a longer period than seven seconds. I further call your attention to the fact that you have not answered this question, but have discussed at length what you interpret as Froment operations. I now repeat my question numbered 112 and ask that you kindly answer it?

A. I did not understand your question. As you now explain it I say that I have never made any test tube experiments with the substances and in the proportions mentioned by me in my test tube repetition of Dr. Byrnes' experiments otherwise than as described in my testimony regarding these experiments. I have no notes
795 that I varied the time referring to the specific example mentioned by you, and my memory is that they were exactly repeated.

115 X Q. Now referring again to your repetition in a test tube of Dr. Byrnes' second example described in the paragraph beginning near the bottom of page 165 of Defendant's printed record, does your experience enable you to state that, had you continued the agitation for a longer period than seven seconds, or had increased the violence of the agitation, or both, a froth might not have been formed?

A. No. My experience would not have led me to believe that a froth could have been obtained.

116 X Q. Then you are unable to shed any light upon what might happen under these circumstances with a more prolonged or more violent agitation other than your inference formed without actually performing the operation. Is that correct?

A. I cannot state a fact. My opinion before I read this experiment of Dr. Byrnes was that I should find the oily mineral at the bottom.

117 X Q. In your answer to my question numbered 103, you have stated how you would proceed if it were your intention to produce what you term "an agitation-froth." Did you ever perform any operation following the lines laid down by you in your answer to that question, except that you used an amount of either cotton-seed oil, olive oil, oleic acid, or other suitable oil, equal to more than one per cent. by weight of the ore operated on, and
796 particularly did you ever, in such an operation, use an amount of a suitable oil equal to 3.6 per cent. by weight of the ore, this latter proportion of oil being that used by Dr. Byrnes in the experiments described by him beginning with the paragraph at the

bottom of page 165 of Defendant's Printed Record and extending through the first two paragraphs on page 166?

A. I have made no such test tube experiments, but I see that your question is not limited to test tube experiments. I have made a number of experiments in which I used more than one per cent. of oil in proportion to the quantity of ore used. They refer to the alleged anticipations which have been produced by the defendant. I find one note in which I say "50 grams of ore, 150 cc. of water, ½ gram of sulphuric acid, 1½ grams of oleic acid, all at bottom." This experiment was made on 22nd of July, long before I had read the evidence of Dr. Byrnes.

I have another experiment here in which I used 400 grams of ore, 1,600 grams of water, 4 grams of sulphuric acid and 12 grams of oleic acid. This experiment was carried out in a cone mixer, and the agitation lasted two and a half minutes. The temperature was 44° Centigrade. The remarks are:

"No froth; granules below sand."

This experiment was made on the 23rd of July, long before I had any knowledge of Dr. Byrnes' evidence.

797 On the same day I made an experiment with the same quantities, except the quantity of oleic acid. That was 20 grams. The temperature was 40° Centigrade. The remarks are:

"No froth; granules heavy, much heavier than sand; granules formed bigger during agitation."

This latter part must mean during continued agitation.

Then I have an experiment on the same day. The quantities the same as before, with the exception of the quantity of oleic acid. That was increased to 40 grams and the remarks underneath are:

"Granules getting bigger and heavier; thin layer of oil on surface."

Where I used 50 grams of ore and 1½ grams of oleic acid, the proportion was 3 per cent. of oil as compared with the ore.

Where I used 400 grams of ore and 12 grams of oleic acid, the proportion was 3 per cent. of oleic acid.

Where I used 400 grams of ore and 20 grams of oleic acid, the proportion was 5 per cent. of oleic acid.

Where I used 400 grams of ore and 40 grams of oleic acid, the proportion was 10 per cent. of oleic acid.

These examples could be continued, but I should like to specifically mention the experiments made with special reference to the Cattermole patent. The quantities of oil used therein are within the limits of your question. The experiments described were made by me only for the purpose of study.

798 118 X Q. In your study of this subject, have you familiarized yourself with United States Patent No. 575,669 of G. Robson, granted January 19, 1897?

A. I am familiar with the principle therein.

119 X Q. What is the substance referred to in this patent as colza-oil?

A. I cannot tell you at present what it is, and I am only consoled for my ignorance that I cannot even find a record under this name in one of the best chemical compendiums which I have at hand. I will let you know after I have looked up in an encyclopedia. It is not a scientific name, and probably the commercial name. I see now from the Standard Dictionary that "colza" is rapeseed, and the same "colza-oil" probably means rape oil.

120 X Q. Can you state anything as to the characteristics or composition of this rape oil?

A. According to my recollection, which, however, I trust only with diffidence, it contains the glycerine esther of oleic acid mixed with other substances. Neither the animal nor the vegetable oils are usually definite substances.

121 X Q. Is this rape oil what would ordinarily be called a fatty oil, as indicated by the patentee Robson?

A. Yes, if my recollection is right.

122 X Q. Can you name some of the substances that would be suggested by the expression "a fatty oil such as colza-oil," this expression occurring in the Robson patent No. 575,669?

799 A. Perhaps it will be better for your purpose if I should look up the constitution of the oil first to make sure to give the right interpretation of the sentence in the patent. I will say, if I am right, that it would mean a fatty oil like olive and others belonging to this class.

123 X Q. Would cotton seed oil come in this category according to your present recollection?

A. Yes.

124 X Q. In your answer to my question X Q. 71, you refer to the production of carbonic acid in the Froment process as "only an incident." From your reading of the Froment British patent, do you arrive at the conclusion that the use of carbon dioxide is of such an incidental character that the ordinary conditions necessary for its production, such as heat in the case of a relatively stable carbonate, should not be created for fear of disturbing some other necessary condition?

A. I have stated that the production of carbonic acid is important, but it is only an incident, because it is a step assisting to achieve the real invention, and the real invention has to be carried out at normal temperatures. No carbonate which requires heat for the generation of gas should be used in this process.

125 X Q. What is this real invention, to which you refer in your last answer?

A. The real invention of the Froment patent is the concentration of minerals contained in an ore, caused by the process of the Froment patent.

800 126 X Q. In any of the operations which you performed following the lines laid down by you in your answer to X Q. 103, did you obtain any flotation of the metalliferous mineral when using more than one per cent. by weight of oil, that is, one per cent. of the weight of the ore?

A. In all experiments along the line which I described in answer

to X Q. 103, the bulk of the minerals was always at the bottom. There may have been at times a small part on the surface as skin flotation, and there may have been at times a thin layer of oil on the surface. I am excluding from this answer experiments made with such quantities of oil which resulted partially in oil buoyancy flotation and partly in the collection of the minerals at the bottom of the vessel. But I should say broadly that the results which I have fully described are the true expression of my experimental experience.

127 X Q. Is your answer to the preceding question limited to those operations in which you used an amount of oil equal to more than one per cent. by weight of the ore? Or does the answer apply to operations including all the quantities of oil which you have used in practicing according to the procedure set forth in your answer to X Q. 103?

A. My answer applies to such experiments which started at the lower limit with the Cattermole proportions of oil, namely, about 1.4 per cent. of oil upon the ore.

801 128 X Q. Did you ever perform any operations along the lines laid down in your answer to X Q. 103, using oil in amounts between 1 per cent. and 1.4 per cent. on the ore by weight?

A. I have no recollection of such experiments. My attention was naturally concentrated on the documents which were referred to by defendant as alleged anticipations.

129 X Q. Will you name all of the different kinds of oils or other selective agents which you have used in your operations conducted along the lines set forth in answer to X Q. 103, and then will you name all of the different kinds of oils or other selective agents used by you in any of your operations whatsoever conducted in your investigations and study of the art of mineral concentration by flotation or by the so-called Cattermole effect?

A. I have used in agitation-froth experiments mostly oleic acid. I have also used in agitation froth experiments cotton seed oil, viscous valve oil, palm oil, lard oil, pinoline, linseed oil, eucalyptus, Texas residue oil, turpentine.

I have used for Cattermole and for flotation and for washing out experiments other than agitation froth, Texas fuel oil, oleic acid, cotton seed oil, crude petroleum, Summer dark oil, a mixture of Texas fuel and paraffin wax, petroleum, a mixture of kerosene and Trinidad asphalt and engine oil.

These are the substances which I can remember.

802 130 X Q. I understand from your answer to X Qs. 126 and 127 that you have never, in your operations along the lines laid down in your answer to X Q. 103, obtained any floating mineral-bearing froth when using an amount of oil or other selective agents amounting to more than one per cent. by weight of the ore. In order that there may be no misunderstanding, will you state whether I have understood you rightly?

A. That is my recollection.

131 X Q. It is in evidence that Mr. A. Howard Higgins, in experimenting with the Cattermole process, the object of which I

understand to be to form the metalliferous minerals into large granules or agglomerates which will have a stronger tendency to settle in water than the gangue, found that, in operating upon Broken Hill ore containing a mineral content of 50 per cent., when using an amount of oleic acid equal to 6 per cent. on the mineral, which I take it would be something about 3 per cent. upon the ore, he obtained good granules "without much froth," and that, as the percentage of oleic acid was decreased, more froth was formed. This does not seem to accord with the results obtained by you, inasmuch as Mr. Higgins' statement, which is contained in his report of March 16, 1905, shows that he obtained some froth when using 6 per cent. of oleic acid on the minerals, that is, 3 per cent. on the ore. Have you any explanation to offer for the difference between the results obtained by yourself and by Mr. Higgins?

803 A. Mr. Higgins gives an explanation and attributes the appearance of the little froth to insufficient oiling and mixing with large quantities of air. Of course, it is difficult for me to explain the experience of a colleague, but I think his explanation is correct. My experiments referring to the Cattermole process usually lasted for about ten minutes. But I myself, as far as my recollection goes, have never worked with an ore of 50% mineral content, which was the ore that Mr. Higgins was working with when performing this experiment.

132 X Q. When, in the treatment of an ore pulp with oil, the particles of metalliferous mineral are caused to unite into granules or agglomerates, is it your experience that these built up granules or agglomerates have a greater or less tendency to sink than do the separate metalliferous particles?

A. My experience is that when a number of very fine particles of mineral are cemented together into granules, such as happens in the Cattermole process, they have a greater tendency to sink than do the separate metalliferous particles. The true phenomenon of specific gravity comes into play.

133 X Q. In your interpretation of the Froment British patent, you have given in one instance a definition to the word "spherule," which, as I understand it, describes the spherule in that instance as an agglomerate or mass or granule of oiled mineral particles.

804 Do these agglomerates, masses or granules, which in one instance you have stated the word spherule refers to, correspond to the agglomerates or granules formed in the Cattermole process?

A. I am speaking from recollection. I believe I explained the word "spherule" in two ways. When Froment speaks in paragraph one of his principles that the oiled particles have a tendency to unite in spherules, I explained that he meant that the oil contained in a particle or in an aggregation of particles would unite with the oil contained in another particle or an aggregation of particles, and that these particles would be combined in the oil, which would form a globule or spherule. In paragraphs 3 and 4 of these principles, he refers to the second kind of spherule, which he calls "metallic spherules," and which one might call "hollow spherules," that is, a bubble of gas, with a layer of oil in which the minerals are embedded.

The spherules referred to by you might be called granules with a much larger amount of oil contained therein.

134 X Q. In your investigation of this subject, did you actually see these different kinds of spherules and granules and did you see them in such a way that you could plainly observe the globules of oil containing sulphides as you have stated in connection with the Froment process, and subsequently see these globules of oil containing sulphides from themselves into an envelope covering a bubble, the wall of which was formed of oil, and did you see all of
805 these things in such a manner that you are able to testify as a matter of fact as distinguished from opinion or inference that all of these things took place?

A. In the Froment process, it is only possible to observe the spherules which have a bubble of carbonic acid enclosed. It is quite easy to see them rise to the top or the surface. When they land, one can observe how they press against other spherules and how the oil gradually flows into a layer, in which these spherules are embedded. The description of Froment is quite correct. Of the first spherules, Froment only states that when particles of ore are moistened with oil, they have a tendency to unite together. He does not speak of the actual production of these spherules. He says this tendency is retarded by the specific weight and opposed by their enclosure within the gangue.

135 X Q. Have you determined, in the case of each of the oils or selective agents mentioned in your answer to X Q. 129, how much of each of them is necessary to form a layer upon the surface of water in a test tube of the kind used by you in making a similar determination upon oleic acid?

A. No.

136 X Q. Is your knowledge as to how much oil is necessary to form a layer upon the surface of water in a test tube of the kind used by you confined to your determination of that amount in the case of oleic acid; ordinary thin lubricating oil and a heavier lubricating oil, these being the substances mentioned by you in answer to X Q. 102?

806 A. I believe I tested also cotton seed oil and olive oil, but I will let you know definitely at the next session.

137 X Q. Do you know the composition of the viscous valve oil referred to by you in answer to X Q. 129?

A. I cannot give you the composition. It is not a definite chemical compound.

138 X Q. I presume that the substance known in the trade as viscous valve oil is not a definite compound or mixture, but is apt to vary according to the ideas of the different makers. Would you expect to find uniformity in substances known as viscous valve oil?

A. No.

139 X Q. Will you answer my preceding question with reference to the substances you refer to as "engine oil," whether this substance, known as mineral engine oil, is one of uniform composition or whether you would expect it to vary when obtained from different sources at different times?

A. I should not expect this substance to be a definite chemical compound. It is required to possess certain physical properties suitable for the uses to which it is put.

140 X Q. What is pinoline?

A. Pinoline is a hydrocarbon belonging to the turpine series. It is a very thin oil. The name comes from pine trees and it is a vegetable oil.

141 X Q. Is pinoline made commercially from pine wood?

807 A. Yes, from pine trees; I think that is the chief source.

142 X Q. How is it prepared; by distillation?

A. I think so.

143 X Q. Is pinoline one of the substances included under the term "wood oil?"

A. I should call it rather a turpine.

144 X Q. What is the substance commercially known as "tar oil?"

A. Tar oil is a result of the destructive distillation of coal. It contains a number of substances.

145 X Q. Are you familiar with a tar oil derived from wood?

A. Yes.

146 X Q. And how is wood tar oil made from wood?

A. It is obtained by the destructive distillation of wood and contains a number of substances.

147 X Q. Are pinoline and wood tar oil products obtained at different stages in the destructive distillation of wood?

A. No, not pinoline.

148 X Q. Are you acquainted with any of the uses of wood tar oil?

A. My knowledge is more intimate of coal tar oil, but I can give you a number of substances which are prepared from wood tar oil. I believe acetone and acetic acid are obtained from it, and I believe we have to rely on the United States for a supply of acetic acid which is obtained from this oil. It is shipped from there in enormous quantities as acetate of lime.

808 149 X Q. Do you know any of the uses to which wood tar oil itself is put?

A. No, except as appears in this evidence.

150 X Q. Do you know whether wood tar oil is the substance used for oiling the ropes used upon ships?

A. I do not know of this use.

151 X Q. Have you ever attempted to ascertain how much wood tar oil is necessary to form a layer upon the surface of water in a test tube of the kind used by you in making your similar determination with regard to other oils mentioned by you?

A. I have not, but if you would like to know, I will do so.

Adjourned to Wednesday, November 13, 1912, at 10:30 in the forenoon, at the same place.

New York, November 13, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Cross-examination continued:

152 X Q. If you were to attempt to apply the Froment process of his British patents to the ore described under the heading "Example 1," set forth in the patent, would you add limestone to the ore?

A. No, I should not.

153 X Q. In operating upon any ore containing a sufficiency of a carbonate, would you, in applying the process of the Froment British patent, add a carbonate thereto in addition to that naturally occurring in the ore?

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A. It all depends on the nature of the carbonate. If, for instance, sodium carbonate were present, I should wash that out and not use it. If there were rhodochrosite present, I should add limestone. It must be limestone or a carbonate which on a test would show the same qualities. I cannot answer the question with yes or no.

154 X Q. Is a quantity of oil approximating the amount you have named 12½ per cent., necessary in the practice of the process of the Froment British patent to secure the floating matter in the form that you have described, that is, in the form of a magma as you have defined a magma?

A. I cannot answer that question. I tried the test tube example with three oils, which are referred to and which have been used by Dr. Byrnes, namely, cotton seed oil, olive oil and oleic acid and also mineral oil, and I tried them in quantities which were necessary to form a layer. I have estimated the quantities necessary. They are slightly higher for cotton seed oil, a little lower for olive oil, and somewhat lower for a rather thin lubricating oil than the 12½ per cent. found for oleic acid. I followed the instructions of the example, and made no variations.

155 X Q. Then I understand you made no attempt to find the least or most economical quantity of oil that, in the practice of the process of the Froment British patent, would form what you have defined as a magma?

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A. I said in reply to one of the previous questions that my investigations were concerned with the alleged anticipations and with the process of the patent in suit. I did not attempt to improve any of the proce ses of these documents by applying knowledge of to-day. I tried to work them as well as I could with the knowledge existing at the time of their discovery, using such knowledge as a competent man might have had at the time. I made no experiments varying the quantities of oil with regard to the Froment test tube example.

156 X Q. Then I take it that you are unable to testify regarding what is the smallest and most economical quantity of oil that, in the operation of the process of the Froment British patent, will pro-

duce the phenomenon which you have described as being a magma? Is this correct?

A. That is correct. If you think it is of assistance to the Court that such an investigation should be made, I am quite willing to do it. It did not appear to assist me in the interpretation of the invention of Froment.

157 X Q. You have said that the principle involved in the operations described in the Froment description referred to in Q. 33, "is skin flotation assisted by bubbles of carbonic acid." Does this skin flotation assisted by carbonic acid bubbles result in the floating products which you have described in connection with the operations of the Froment British patent?

811 A. No. The result of the instructions is purely skin flotation, assisted and induced by attachment of carbonic acid bubbles to the oiled minerals. It is not like the magma as I have seen it in the test tube example of the Froment patent.

158 X Q. What is your conception of a process, that is, a technical process of the general type now under discussion by us?

A. From my knowledge of what has been applied as a technical process to the ore concentration industry, there is as a type the Elmore process, that is, oil buoyancy flotation by reduction of the specific gravity of a mixture of a heavy oil with minerals to such a degree that it is lighter than water. The second process which has been found practical is the Cattermole process, the phenomenon of which is the increase of the falling power of oil agglomerated minerals to such an extent that the falling power is much greater than the falling power of the gangue. The third process is the process of the patent in suit, which, in consequence of its incredible economy, has superseded the two previous processes. My conception of a technical process is, I am speaking now of the present day, a process which is at least as economical as the agitation-froth process, whilst, at the same time, giving at least the same return.

159 X Q. Please give your definition of the word process.

A. A process is one or a number of operations carried out
812 with certain materials for the production of a certain result.

160 X Q. Is the process set forth in the Froment description the same process as that of the Froment British patent?

A. The process revealed in the instructions differs essentially from the process as revealed in the test tube example of the Froment patent, and it differs in essential points from the process which is not described in the Froment patent but which I said might be inferred from the general description and from the claim. One of these is a de-sliming operation which is necessary, according to the instructions; but that is only one.

161 X Q. You refer to the Froment description as recommending that the concentrates be subjected to high pressure in a hydraulic or filter press for the recovery of the oil. Do you think this would be a practical operation as applied to the concentrates obtained according to the process of the Froment description?

A. It is quite a feasible process and a sound one, if my recollection of the instructions is right. Froment says that it is the custom

in the Latin countries, that is, Italy, Spain and France, to treat ores of a low mineral content. If you have an ore, say, containing 5 per cent. of a metal, of which, however, I believe that it is scarcely ever done with certain metals such as zinc or lead, in other countries, the concentrates would contain about 15 to 16 per cent. of oil, and part of that could be recovered. In many cases, perhaps a recovery could not be effected of the oil, but Froment tried in his in-
813 structions to provide for all emergencies.

162 X Q. Now, referring to the operation set forth in the paragraph following the paragraph numbered 4 in the complete specification of the Froment British patent, would it not be the case that, if a poor ore were operated upon, for instance, an ore containing about 5 per cent. of blende or copper sulphide, and an amount of oil were used equal to 1 per cent. upon the ore, contrary to your interpretation regarding the amount of oil, the concentrate obtained would contain a comparatively large amount of oil, an amount capable of separation in a filter press as stated by you in connection with the process of the Froment description?

A. My answer on your assumption is, yes, provided there are no other minerals of the type present, which nearly always are in copper ores, and assuming that all the oil was in the concentrate and no gangue.

163 X Q. In your answer to Q. 32, you state that Froment says, in his Italian patent, "when a gas is generated in this mass, etc.," certain things will follow. Will you please state what words occurring in the Italian patent you translate by the use of the English word "generated"?

A. Se degage. I could not think of another translation.

164 X Q. Is not the French verb "degager" of broader significance than the English word "generate," using the word generate as confined to chemical action, and is there not another word
814 in the French language which would ordinarily be used to represent the idea of generation of a gas by chemical action alone?

A. As I understand the meaning of the word "se degage" it can only mean generated. There is another word in the French language which means the same, namely, generated. I think the other French word is "engendrer," but I am not quite sure about it.

165 X Q. Are the English words "disengage" and "liberate" equivalents of the French verb "degager"?

A. I think that is correct.

166 X Q. You have attached different meanings to the word "spherules" as used in the paragraph numbered 1 and the paragraph numbered 4 of the complete specification of the Froment British patent. I invite your attention to the fact that, in paragraph 4, the metallic spherules are referred to as "these metallic spherules." Does not the use of the word "these" show that in paragraph 4 Froment is referring to the same spherules previously mentioned, namely, those referred to in paragraph 1? In this connection, I also invite your attention to the fact that, in the Italian Froment patent, the expression "ces spherules metalliques" is used.

A. My reading is that "these metallic spherules" refer to paragraph 3, namely, to "the bubbles of the gas become covered with an envelope of sulphides," and not to the "spherules" mentioned in paragraph 1.

167 X Q. You state, referring to the Froment operations
815 described in his British patent in the paragraph following the paragraph numbered 4, that the calcite is present only as a source of carbonic acid, yet Froment uses for the decomposition of one gram of calcite only a few drops of sulphuric acid. This would show, would it not, that in the test tube operation Froment did not decompose all of the gram of calcite used?

A. The expression "a few drops" is very loose language, no doubt. It is reasonable to assume that he poured the acid from a bottle and the drops would be thus larger than the drops, say, from a pipette or a burette. Then again, "a few drops" is nothing definite. I should say the measure for the acid would be the quantity of calcite or limestone which he specifies. That enables the metallurgist to use a quantity which gives him all the benefit that can be derived, namely, the full quantity of gas contained in the limestone. With a few drops of sulphuric acid, he probably has some of the limestone left unattacked.

168 X Q. In most localities I believe you have said that limestone is a comparatively cheap and common substance. At any rate, this is so, is it not?

A. That is so.

169 X Q. And, as compared with limestone, sulphuric acid is quite an expensive substance, is it not?

A. I cannot tell about the price of limestone. The price of a ton of sulphuric acid, the ordinary brown oil of vitriol, I believe is 25 shillings, or about $6.00.

170 X Q. Assuming that limestone is cheaper than sul-
816 phuric acid, would not a convenient mode of generating a desired amount of carbon dioxide be to use an excess of limestone and to regulate the amount of carbon dioxide by the quantity of acid used, and would not the consumption of the entire amount of acid be more nearly effected by providing an excess of limestone over and above the precise amount necessary for reaction with the sulphuric acid?

A. Your question is not confined to any specific utilization of the carbon dioxide. As a general proposition for the production of carbon dioxide to be collected, it would be advisable to add the sulphuric acid gradually but you still must have the full amount of acid to get the full benefit from your limestone; but sulphuric acid is scarcely ever used for the purpose. In a laboratory, if I wanted to generate a desired amount of carbonic acid, I should take the quantity of limestone which could furnish it and I should take a slight excess of acid to generate it. That is the usual practice, and the most convenient way of doing it. You may easily leave a portion of the acid unused if you have not an excess present, and if you want to get a desired quantity, you ought to have an excess of the acid over the limestone. If you have an excess of limestone over sulphuric acid, there is no

reason why the sulphuric acid should not be consumed, but it would not be any more nearly effected by providing an excess of limestone. But I disagree with the first part of the question, it would be a wasteful mode as the excess of limestone would be wasted, and as
817 there is no necessity for it.

Adjourned to Thursday, November 14, 1912, at 10:30 in the forenoon, at the same place.

New York, November 14, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination continued:

171 X Q. In performing the operations set forth in the paragraph of the British Froment patent following the paragraph numbered 4, would not a reduction of the quantity of carbonate used, in pursuance of Froment's caution that there is a proportion to be sought for a given ore and limestone, lessen the quantity of carbon dioxide evolved and thereby prevent the evolution of so much gas as to project the contents of the test tube therefrom?

A. A reduction in the quantity of limestone would necessarily reduce the quantity of gas, namely, carbonic acid, if as I have stated to be my understanding, the quantity of limestone is the measure of the quantity of sulphuric acid to be used. If there were an excess of limestone over sulphuric acid, then there need not be a reduction in the quantity of carbonic acid produced.

172 X Q. You have stated that, according to your inter-
818 pretation, the agitation directed by Froment in the specification of the British patent is for a very short period, as practised by you from two to seven seconds, and you state that agitation for such a short period must be advice to generate the carbonic acid as quickly as possible. Will you state how the very short period of agitation would have the result of generating carbonic acid more rapidly than a longer period?

A. It is well known to chemists and metallurgists that in such operations as the action of sulphuric acid on limestone, the evolution of carbonic acid gas is instantaneous if you operate in such a manner that you bring the whole of the limestone into intimate contact with the whole of the acid. Froment directs an operation lasting in all its phases for a few seconds and that clearly is advice to metallurgists that he wants practically instantaneous evolution of the carbonic acid. A longer period of agitation, in view of Froment's description and instruction in the patent, would not only be contrary to Froment's instructions, but would be utterly useless. Froment wants to make use of the carbonic acid in the nascent state and that he can do only by operating in the way as described. A longer agitation would destroy all the benefits which he derives from the gas in its nascent state. I answer, therefore, Froment directs the short duration of his whole process because he knows that the evolution of carbonic acid from limestone by sulphuric acid is instantaneous and he wants

the use of the carbonic acid in its nascent state as, according
819 to his researches, this condition of the gas is highly beneficial to this process. A longer agitation would defeat this object. I did not state that a short period of agitation would have the result of generating carbonic acid more rapidly than a longer period, but I said it is advice to generate it as quickly as possible, that is, by bringing quickly all the calcite into contact with the acid.

173 X Q. If it were Froment's desire to generate the carbon dioxide as rapidly as possible by securing as quickly as possible contact of all the acid with all the limestone, this would indicate, would it not, according to your reasoning, that the agitation should be of as violent a degree as possible?

A. That does not necessarily follow. A comparatively gentle agitation will keep finely powdered limestone in suspension.

174 X Q. You state that one may infer from the words occurring in the Froment British patent "the formation of the spherules and their separation from the gangue" that the patentee contemplates first the production of oiled minerals heavier than water and buried in gangue. In view of the test tube operation described by Froment in his British patent, would it not be more reasonable to interpret the expression quoted as meaning that the separation of the spherules from the gangue takes place while both the gangue and metalliferous mineral are in suspension in the water?

A. No, I cannot even imagine such a meaning. I submit
820 that the inference which I drew is the more reasonable one. But I will say that the Froment document is in a great many respects a puzzling document and leaves a great deal to the individual imagination with which a reader is endowed.

175 X Q. In your answer to Q. 32, you quote the claim of the Froment British patent, following which you make a statement which I understand to mean that the claim does not set forth the same process as that involved in the test tube operations described by Froment. I am unable to understand exactly what difference you intend to point out between the process of the claim and that of the test tube operation. Will you kindly state whether I have understood you rightly, and, if so, will you state precisely the difference between the process of the claim and that involved in the test tube operation?

A. I read the claim in the following way: Add the ore to the water, mix; add a suitable oil; mix; add an acid to liberate a gas in the mixture. That seems to me a reasonable explanation of the claim and it satisfies me to a great extent as a chemist, but I confess again that the claim is a very general statement and it must be read to have the meaning which I gave in connection with the several parts of the document from which I have drawn a similar inference. But I am sure that the claim cannot refer to the test tube example.

176 X Q. In your answer to Q. 33, you refer to that part of the Froment deescription which recommends the addition of
821 1 to 2 per cent. of carbonate of lime to the ore. Is not this an amount of carbonate of lime, that is frequently found in ores as a natural constituent thereof?

A. A carbonate of lime is very often found present in ores. The amounts vary.

177 X Q. In answer to Q. 33, you state that there is no necessity for the pipe for admission of steam to the Froment apparatus, except for cold countries, and that the steam pipe is only provided to prevent the freezing of the plant. Does Froment state this purpose for the steam pipe in his description?

A. In his instructions he states that the use of steam

"is only necessary in cold countries."

178 X Q. Does Froment in his description say anything about the steam supply being provided only to prevent freezing of the plant?

A. Not in these words.

179 X Q. If the Froment plant were to be used in a locality where the temperature of the water used was only a degree or two above the freezing point, I understand it to be your interpretation of the Froment description that the steam supply was not contemplated for the purpose of raising the temperature of the water to such a point as would be conducive to the production of the result set forth in the Froment description. Is that correct?

822 A. No, I should not put such a narrow construction on it. Froment clearly intends his process to be used at normal temperatures such as they occur in the moderate climates of Europe. If the temperature were such as you say, it might be reasonably presumed that he might have used the steam for heating up his water to normal temperature. Of course, it is quite well known to every metallurgist that the action of carbonic acid is equally energetic at 2 to 3 degrees Centigrade, as at 15°, and I, therefore, said, as I think quite justly, that he meant to prevent the freezing of the plant by the use of steam.

180 X Q. In the document which has been introduced in evidence as Sulman and Picard Report of May 3, 1905, I find the following statement:

"This upcurrent tends to keep the fine sands product free from gangue slimes and also to prevent the falling of any mineral flocks from the float froth traveling over it, or to return such flocks again to the surface."

Will you define what these flocks are and what leads to their formation in the practice of the process of the patent in suit, this being the process, as I understood it, under discussion by Messrs. Sulman and Picard in their report of May 3rd, 1905, referred to?

A. The word "flock" does seem to be used with a number of meanings, but Mr. Sulman in his evidence makes it quite clear what he means by it. I quote from his answer to Q. 110 on page 261

823 of Defendant's Record:

"The slime mineral particles appear to be closely associated with each other and with the larger particles, at times, in the form of spongy flocks, the whole mineral being so intermixed, as regards

its varying sized particles and flocks and with the air bubbles as to form coherent froth of somewhat spongy nature. The nature of the froth varies somewhat with different minerals, but all have the same specific matter, coherent and persistent characters when the plant and process are operated to their best purpose and effect. The froth so obtained when broken down by mechanical means or by draining results in a deposit of the mineral particles, which exhibit to the touch and upon inspection, no visible traces of oil, and one would not suspect the presence of oil therein unless an analysis were made. One essential for such a froth is the inclusion therein of slime mineral, as without the aid of such fine material our experience is that the specific agitation froth we obtain normally cannot be formed."

I quote further from the report referred to:

"Should any slight amount of froth sink during this floating off process, a slight stirring by hand of the contents of the mixer will at once bring to the surface any such particles of sunk froth."

824 It is clear that Mr. Sulman, in the passage of his report quoted in the question, calls such parts of the froth which might sink during the floating off process, flocks, as the froth which had sunk presented probably such an appearance. He described in his testimony which I quoted that the froth appeared to him like "spongy flocks," and I quite agree with this description of the froth. On looking at the agitation froth, it presents an appearance like a sponge and it is quite correct to say that it is a coherent froth of somewhat spongy nature. I understand that the flocks referred to in the question are the "slight amount of froth" sunk "during this floating off process."

181 X Q. Referring to the sentence which you quote in your preceding answer from Sulman and Picard's report, May 3, 1905, how would you understand that the "slight stirring by hand of the contents of the mixer" was to be performed; I mean, by a spatula or rod or what would you consider would come within the expression referred to?

A. I understand that the mixer, or rather the belt which served for turning the mixer, was moved by the hand instead of by the electric motor.

182 X Q. In any of your experiments in flotation by the use of oil, have you observed any tendency for flocks of minerals to sink instead of remaining upon the surface?

A. The term "flocks," as I said before, does not convey a distinct meaning. It has been used by Mr. Sulman in the sense
825 explained by me. It has also been used to denote an aggregation of particles in oil. I have seen little parts of a froth fall to the bottom and I have also seen aggregations of particles in oil fall to the bottom. As a rule, however, aggregations of particles in ore are at the bottom.

183 X Q. In your investigations, how have you found the degree of agitation necessary in what you term the agitation-froth process to compare with the degree of agitation necessary in the first stage of the

Cattermole process, it being my understanding that, in the Cattermole process, there are two stages of agitation, the first comparatively violent for the purpose of distributing the oil over the metalliferous particles, and the second stage being more gentle or more in the nature of a mass rotation of the pulp, rather than an agitation that would impart great turbulence to it?

A. It has been stated in this evidence that to obtain larger and firmer granules, the second agitation in the Cattermole process might be varied. But that is not necessary and as I undersand the patent, the patentee leaves the use of a variation of the second agitation optional. I have carried the process out in two ways; in one way, I used the same agitation for both operations; in the second way I removed the baffles from the cone mixer and got a different form of agitation. The granules produced by the latter experiment were larger than the ones produced by the former agitation. The determination of the agitation suitable for the process of the patent
826 in suit and for the process of the Cattermole patent is very simple. Cattermole requires an agitation which is sufficient to oil the mineral particles. The patent in suit requires an agitation which is sufficient to oil the particles and to draw in air and beat it up in a fine enough form so that it can commingle with the oiled particles. I am speaking from memory now. I believe that 500 to 600 revolutions are quite sufficient for the Cattermole process. But I believe that at least 1200 revolutions per minute are necessary for the process of the patent in suit, in the same apparatus. That is easily determined by a simple experiment. Cattermole also has much larger quantities of oil as compared with the patent in suit, which again requires less agitation.

184 X Q. The number of revolutions which you have referred to in your preceding answer relates to the small apparatus or to the large apparatus used in commercial practice?

A. The number of revolutions relates to the small apparatus. I guarded myself by saying I was speaking from memory. It has been often mentioned in these proceedings that there were two small apparatus used, one called the slide machine, and the other the cone mixer. They are both of the same size about. I am definite about the number of revolutions referring to the Cattermole experiments, but I am doubtful whether I did not use a higher speed for the agitation-froth process in the apparatus used for the Cattermole
827 process when using it for the agitation of the patent in suit. I will, however, give a definite answer tomorrow.

185 X Q. Do you agree with the statements made by some of the witnesses in this suit to the effect that the correct mode of estimating the degree of agitation is by reference to the peripheral speed imparted to the agitator, rather than by reference to the number of revolutions per minute of the agitator?

A. Given the same kind of apparatus, the peripheral speed is the chief determinant of the degree of agitation.

186 X Q. With a given number of revolutions per minute, the peripheral speed imparted to an agitator would be proportional to the diameter of the agitator, would it not?

A. The formula to determine the circumference of a circle is d. w. d. meaning the diameter of the circle, and w. meaning a constant. You are quite right. The speed of the periphery of a larger agitator is in proportion greater to the smaller one in the same way as its diameter differs from the diameter of the smaller circle.

187 X Q. That is, stated in another way, at the same number of revolutions per minute an agitator having a diameter of 2 feet would have twice the peripheral speed of an agitator having a diameter of one foot?

A. I agree, and I add that counsel has put it in the most admirably logical and simple way.

188 X Q. In your answer to Q. 34, you made the following statement.

828 "The conclusions from these experiments are that it is impossible to produce the Froment result with the proportions between ore, oil and acid which Dr. Byrnes used in the slide machine experiments described on pages 165 and 166 of Defendant's Record, and I say deliberately that it is impossible with such proportions to produce the Froment result of the test tube example, namely, causing the whole of the mineral to rise instantly to the top of the liquid in the form of a magma. It is obvious and self-evident from the result of these experiments that Dr. Byrnes' experiments cannot be in accordance with and are not the invention revealed in the Froment patent."

Do not the experiments performed by Dr. Byrnes, regardless of whether you consider them Froment operations or not, show that a froth can be produced using quantities of oil largely in excess of the quantities specified in the patent in suit?

A. I have myself not made such an experiment and I am not speaking from personal experience. I am of opinion, as I stated, that if a froth is produced with quantities of oil such as are used in four of the five experiments, it must lack some of the characteristics of the agitation froth; that is, for instance, it would not show the metallic lustre and would be oily. Dr. Byrnes says he has produced a froth with a large quantity of oil. If it is produced, it is not pro-

829 duced by the Froment process, but by the process of the patent in suit. A froth such as can result from the quantities of oil used in four of the experiments would be valueless for the reason of its great expense.

189 X Q. Will you state whether you have determined how much wood tar oil is necessary to spread over the surface of water in a test tube of the kind which you have used in your investigations, and, if so, will you state what the quantity is?

A. I have procured a sample of wood tar oil. It did not form any layer on water. It sank to the bottom because it is specifically heavier than water. If I had been thinking carefully, I would have been able to answer the question before. In the destructive distillation of wood, a distillate is obtained which consists of three layers, the bottom layer is a wood tar oil, the medium layer is an aqueous solution of acetic acid, and the top layer is a solution of methyl,

alcohol and acetone. This is a recollection of my earliest student days.

190 X Q. In experimenting with the wood tar oil, did you try dropping the oil upon the side of the test tube and letting it run down on the surface of the water, or did you try in any other way to dposit the wood tar oil gently upon the surface of the water, and, if so, did you not find that one drop of the wood tar oil would spread over the entire surface of the water and form a layer thereon?

Adjourned to Friday, November 15, 1912, at 10.30 in the forenoon, at the same place.

830 New York, November 15, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Cross-examination continued:

A. I dropped some wood tar oil which I used in the middle of the test tube and it went down. I tried the experiment suggested in the question. When pouring it down the side of the test tube, it stuck and would not form a layer. To reduce the viscosity I warmed it, and repeated the experiment. It did not form a layer, but slid down the glass wall and went to the bottom.

191 X Q. My question related to wood tar oil and I now ask you whether you have ever deposited upon the surface of water in a test tube a drop either of the substance commercially known as pine tar oil, a drop of turpentine, a drop of a mixture of turpentine and a fatty oil, in the proportion of fatty oil from 10 to 25 per cent. of the tar mixture, the latter being the proportion mentioned in the United States patent to Robson, or to Robson and Crowder, as it has been referred to in this record, No. 575,669, or a drop of pine oil or pinoline, or a mixture of pine tar oil and a fatty acid, or a drop of crude eucalyptus oil, or of refined eucalyptus oil, and also ask you whether you did not find that, in the case of most of these oils or mixtures, a single drop would form a layer covering the entire surface of the water in the test tube.

831 A. The wood tar which I used was procured here and is called American pine wood tar. I called it wood tar oil because it is usually called that way. I sent out to procure Stockholm wood tar, which is a very well known product, and of which I know it has been used in the process of the patent in suit. I have tried none of the other oils mentioned in the question with the exception of eucalyptus oil, and I say that one drop does not form a thin layer.

192 X Q. Did you ascertain how many drops of eucalyptus oil would form a layer upon water in a test tube?

A. The quantity required of eucalyptus to form a layer which could be seen was .225 cc. I gave these second and third decimals as a guess. It was between .2 and .25 cc. This quantity is giving you the lowest possible quantity which would be called the thinnest possible layer.

193 X Q. Is the wood tar referred to by you in answer to X Q. 191, a different substance from that sold commercially as pine tar oil?

A. I could not say.

194 X Q. Will you, for the information of the Court, upon this matter which you have discussed as to the amount of oil necessary to make a layer on the surface of water in a test tube, ascertain how much of each of the substances referred to by me in X Q. 191 is necessary to form a layer upon the surface of water in a test tube of the kind used by you previously, and, in the case of those
832 substances which have a greater specific gravity than water, will you make your determination by depositing the oil gently upon the surface of the water, as may easily be done and naturally would be done by dropping the oil upon the side of the test tube and letting it run upon the surface of the water? If requested, I will furnish you with the substances referred to or direct you to dealers where these substances may be purchased in any quantity.

By Mr. Williams: Timely objection is here made to the present and preceding question as calling for matters utterly irrelevant to the issues herein.

By Mr. Scott: While not desiring to make any argument at this time, the attention of the Court is invited at this point for the purpose of convenience, to the elaborateness with which the quantity of oil necessary to form a layer on water in a test tube has been discussed by the witness in connection with the instructions of the Froment British patent to use "a thin layer of ordinary oil." In view of the facts shown by the record no explanation of the relevancy of the question is necessary.

By Mr. Williams: Defendant's case is closed. Defendant's expert has given his views of the Froment patent. No foundation was laid in that testimony for the view that any of the materials mentioned, such, for example, as turpentine, were the "ordi-
833 nary" oils referred to by Froment, in his modification of what was known in 1902 as the oil process of ore concentration. The objection that this matter is utterly irrelevant is submitted to be clearly warranted.

By Mr. Scott: Defendant's expert gave his views that a very small quantity of oil was necessary to form a layer. He made no attempt to enumerate the endless number of ordinary oils. The foundation for reference to ordinary oils is in the Froment British patent, and no further foundation for reference thereto is necessary. Defendant's expert, in his experiments, plainly shows that he interpreted the Froment instructions to use a thin layer of oil as signifying that small quantity of oil which one familiar with the physical properties of oils would naturally use. It is submitted that the question objected to is proper, in that it is sought thereby to present the views expressed by defendant's expert from being rebutted by reference to a few selected oils which it has been stated require to be used in an amount equal to 12½ per cent. of the ore in the case of the Froment operations to form a layer. The views expressed by defendant's expert witness should not be subject to rebuttal by testi-

mony so limited, but, if an attempt is made to rebut them, that attempt should include a statement of facts with reference to any oils coming under Froment's instructions rather than by
834 reference to two or three particularly selected oils. Furthermore, one of the mixtures referred to in the question is a mixture recommended in one of the prior art patents covering an oil concentration process.

By Mr. Williams: Entering with diffidence at this time upon an argument to make clear the reasons for an objection, complainants' counsel merely calls attention to the fact that defendant's expert did not use any of the oils called for or in any manner refer to them in connection with his testimony, and to the further fact, which is perfectly clear from the evidence, that the Robson and Crowder worthless oil washing process was not "what is known as the oil process of ore concentration" in 1902.

A. I have made the tests referring to this question with the ordinary oil, which is clearly described by Froment. I have then applied the same test with the oils which Dr. Byrnes considered to fall under this specification. I have never made an attempt, and I never stated so, to bring a complete investigation of the layers which all the oils could form on the surface of water before the Court. I am quite willing to do so, and will do so if I can. I want to express my thanks for the lesson which counsel gave me in carrying out a very simple operation. I have had thirty-seven years' experience in chemistry and, I say this with great diffidence, my name is pretty well known in Europe. But I am always delighted to learn.
835 I shall carry out these tests in such manner, as I have carried out all the tests in this litigation or in any other matter, conscientiously and to give such information to the Court which will be of assistance to the Court and not be misleading to the Court.

195 X Q. Will you state the specific gravity of the eucalyptus oil which you used in estimating the amount necessary to form a layer in a test tube?

A. I do not know it.

196 X Q. Is it greater or less than water?

A. From the result of experiments, I should say that it was less than water.

197 X Q. In your reply to Q. 34, you refer to an agitation such as will commingle air with a mixture of ore pulp with a quantity of oil. Would not any degree of agitation sufficient to commingle oil with the pulp in such manner as to moisten the metalliferous particles also have the effect of aerating the pulp, that is, the effect of causing the pulp to be interspersed with air bubbles?

A. No, not in my experience. To produce the result of the patent in suit requires much more aeration than can be obtained by an agitation sufficient to moisten the metalliferous particles of the pulp.

198 X Q. My last preceding question did not call for any statement as to the amount of aeration required by the patent in suit, but inquiry was simply made as to whether the agitation

836 necessary to commingle the oil with the pulp sufficiently to moisten the metalliferous particles with oil would not have the effect of aerating the pulp; that is, causing the pulp to be interspersed with air bubbles. Will you kindly answer the question without reference to your opinion as to whether such aeration would be sufficient for the purposes of the patent in suit?

A. The process of agitation required for moistening the mineral particles with oil may, or may not, mix some air bubbles with the pulp, and might conceivably produce some skin flotation.

199 X Q. In view of your opinion as to the amount of agitation or degree of agitation necessary to produce the result aimed at by the process of the patent in suit, would you consider it sufficient to instruct the operator to agitate the pulp containing oleic acid until the oleic acid had been brought into efficient contact with the metalliferous particles of the ore or would you consider further instructions necessary?

A. In carrying out the process of the patent in suit, I should instruct the operator to agitate in such manner that, by the introduction of the air resulting from the agitation, the oiled mineral particles would rise in the form of a froth to the surface. The instructions in the patent are absolutely clear. I assume that your question also includes the other conditions which are mentioned.

200 X Q. In commenting, in your answer to Q. 34 upon Dr. Byrnes' experiment described in the paragraph beginning at
837 the bottom of page 165 of Defendant's Record, you state that "the concentrates produced on the surface of the liquid are both in appearance and character entirely different from the agitation froth of the patent in suit," and you further state that "the oily character of the minerals is clearly visible to the naked eye." As you have stated that you did not repeat Dr. Byrnes' experiments in the slide machine, will you kindly state what experience you base your quoted statements upon?

A. I have seen many times concentrates produced even with much smaller quantities of oil than used by Dr. Byrnes, and in each case I found the appearance greatly different from the appearance of the agitation froth. Even quantities as small as 1.5 per cent. alter the look of the mineral particles.

201 X Q. Do you understand the process of the patent in suit to be a process for the production of a froth having the appearance and characteristics you have described as pertaining to the froth produced by operations conducted according to the instructions of that patent, as distinguished from a froth having the appearance described in the passages of your testimony quoted in X Q. 200?

A. I gave my description of the characteristics of the froth of the patent in suit, of such froth which I had produced with quantities of oil which the patentees described as suitable and economical. It is a question for the Court to say whether a froth produced
838 with wasteful quantities of oil by the process of the patent in suit is a froth of the patent in suit.

202 X Q. In your answer to Q. 34, in commenting upon Dr. Byrnes' fourth and fifth experiments described by him in the last

three paragraphs of page 166 of Defendant's printed record, you state that, upon analysis of the different grades of oleic acid used by Dr. Byrnes, you found the same total quantity of palmitic and stearic acid in each of them. Did you carry your analysis of these substances to such a point as to ascertain whether there might have been other differences between them which could have influenced the results secured by Dr. Byrnes?

A. My answer quoted was not a comment on Dr. Byrnes' evidence with regard to these experiments. I was only stating a fact which I had ascertained by analysis and I stated then that Dr. Byrnes' implied theories about the difference of results was not in accordance with this fact. Commercial oleic acid usually contains only as impurities palmitic and stearic acids, and the analysis is always directed to ascertaining the quantities of real oleic acid whereby also the quantities of palmitic acid and stearic acid are determined. Whether this particular oil contained any other mysterious substance, I cannot tell, and whether such a mysterious substance could have any influence on his results I am also unable to state. My analysis was only directed to ascertain the amount of oleic acid present in the two samples.

839 203 X Q. In your answer to Q. 35, you state that you have proved definitely that it is impossible to produce aeration according to the test tube experiments described by Froment. Will you explain what this proof is or refer me to your testimony on the subject if you have already set it forth.

A. This statement refers to the statement of Dr. Byrnes contained on page 170 of Defendant's Record, to the effect that,

"In his test-tube experiment, agitation sufficient to coat the mineral particles with a thin film of the oiling agent also thoroughly aerates the mixture, the fine bubbles of air distributed throughout it, and attaching themselves to the oiled particles, acting with the chemically-evolved gas to float them."

My proof of my statement which you have quoted is in evidence and I add further that, if Froment had had any conception of such an aeration, he certainly would have stated it and he would not have used the generation of carbonic acid in a nascent state.

Adjourned to Saturday, November 16, 1912, at 10:30 in the forenoon, at the same place.

840 New York, November 16, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Cross-examination continued:

204 X Q. Have you made the determination referred to in my questions numbered 191 and 194, and, if so, with what result?

A. I procured the following samples: turpentine, wood tar oil, pine oil and sweet pine oil (pinoline). I made the tests which you desired with these four samples and also with a mixture containing

90% of turpentine and 10% of olive oil, and a mixture containing 75% of turpentine and 25% of olive oil. I made the tests in the way suggested by you and in the way it is usually done. The results were:

The layer of turpentine on water done

In your way required..... .175 cc.
In the usual way..... .15 cc.

The thickness of this layer is 15/1000 of an inch or 0.0151 inch.

The layer of a mixture containing 90% of turpentine and 10% of olive oil done

In your way required..... 0.175 cc.
In the usual way..... 0.175 cc.

The thickness of this layer is 18/1000 of an inch or 0.0176 inch.

841 The layer of a mixture containing 75% of turpentine and 25% of olive oil done

In your way required..... 0.25 cc.
In the usual way..... 0.225 cc.

The thickness of this layer is 23/1000 of an inch or 0.0227 inch.

The layer of wood tar oil on water done

In your way required..... 0.225 cc.
In the usual way..... 0.2 cc.

The thickness of this layer is 20/1000 of an inch or equal to 0.0201 inch.

The layer of pine oil on water done

In your way required..... ..... 0.25 cc.
In the usual way..... 0.25 cc.

The thickness of this layer is 25/1000 of an inch or 0.0252 inch.

The layer of sweet pine oil or pinoline on water done

In your way required..... 0.15 cc.
In the usual way..... 0.15 cc.

The thickness of this layer is 15/1000 of an inch or 0.015 inch.

I understand now why you recommended the unusual method for doing these tests, namely, by dropping the oil on the side of the test tube and letting it run upon the surface of the water. Two of the oils, wood tar oil and pine oil, are heavier than water and can only be maintained on the surface by surface tension. But

842 it is quite easy to succeed to do this by dropping them in. I still think that the ordinary method is the more accurate one.

205 X Q. Did you observe how many drops of these different substances were necessary to constitute the quantities which you have named?

A. I can only give you the number of drops by calculation. As far as I remember, the pipette which I used for dropping into the test tube gave 14 drops for .4 cc. That will give for .15 cc. about four to five drops.

206 X Q. In your answer to Q. 29, in your remarks about the Schwarz patents, you state that "the patentee directs you to aerate the mixture of ore and oil and not the mixture of air, oil and water." I invite your attention to the fact that in Schwarz patent No. 807,501, page 2, lines 20-24, and in Schwarz patent No. 807,503, page 1, lines 94-100, reference is made to mechanical agitation and the injection of air, steam or gas during the treatment with water. Do not these statements of the patentee modify your interpretation as set forth in the passage quoted in this question from your testimony?

A. No. I quoted the passage from the document (807,503, page 1, lines 94-100) to which you have referred in your question, together with other parts which explain it, and I had the specific part showing that the admission of air, etc., may be continued actually underlined. From the language, it would appear that this part of the process is optional.

843 207 X Q. I invite your attention to the following passages occurring at page 2, lines 106-116, and page 3, lines 27-30, of the patent in suit, as follows:

"The products suspended in circuit liquor are removed from the spitzkasten and placed in a vessel in which they are submitted to an additional pressure of air or other gas of from, say, one or two atmospheres or over. On relief of such pressure the bubbles of air or other gas so generated throughout the mass at once sweep to the surface thereof all the metalliferous matter in the form of a froth which can be separated as before" (page 2, lines 106-116).

"The whole of the mineral to which air bubbles are attached—say the oiled mineral—at once rises to the surface as a coherent scum or froth" (page 3, lines 27-30).

In connection with the patent as above quoted, I ask you whether a coherent froth cannot be formed by the liberation of a gas in an ore pulp, as well as by the introduction of gas therein by agitation?

A. I have not given any consideration to this part of the patent. Dr. Byrnes also passed it over. But there is no doubt, and it is well known, that, if you compress air and if it is in contact with a liquid, the amount of air dissolved in water is in proportion to the pressure to which it is exposed. If air is soluble in water at ordinary pressures in the proportion of .02 volume per hundred volume of water,

844 the solubility is increased to double the quantity at an over-pressure of an atmosphere, and so on. If that pressure is relieved, the air will be liberated from the solution. I cannot speak as to the froth produced, either to its appearance or to its consistency, as I have never seen it. This operation, namely, compressing the air, must be carried out in a vessel which will stand over-pressure. Such vessels are usually called auto-claves.

208 X Q. I invite your attention to the following passage occurring in "Complainants' Exhibit, Froment Description,"

"Steam at low pressure arrives through the holes in the coil and assists the reactions."

Does not the passage above quoted from Froment's description modify your views heretofore stated to the effect that the only purpose of using heat in the Froment process is to prevent freezing or to raise the mixture to normal temperatures, namely, approximately 60° Fahrenheit?

A. It would, if it were standing by itself, but I submit that the next sentence,

"This is only necessary in cold countries,"

gives the true meaning, namely, that the steam is intended for increasing the temperature which may exist in cold countries to normal temperatures, and that this is the function of the steam.

845 209 X Q. Are the concentrates which you refer to in your answer to my question numbered 200, floating concentrates?

A. Both floating and non-floating. The non-floating concentrates were products such as Cattermole; the floating concentrates were concentrates which floated by surface tension and which had been made to float by the introduction of air through pipes. That is what I at present remember.

210 X Q. Will you state what the thick residuum oil was which one of the witnesses in this suit refers to as having been used in the Elmore bulk oil flotation process?

A. The thick residuum oil used in the Elmore bulk oil flotation process is a residue of petroleum. I believe ordinary types are called Winter Dark Oil and Summer Dark Oil.

211 X Q. Can you give some approximate idea as to the cost of this thick residuum oil in different localities?

A. No. I am sorry I cannot help you there.

212 X Q. Can you give any information as to the comparative cost of thick residuum oil and the substances which are sold as mineral engine oil?

Adjourned to Monday, November 18, 1912, at 10:30 in the forenoon, at the same place.

846 New York, November 18, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Cross-examination continued:

A. No. I tried to get the information, but did not succeed. As Dr. Chandler follows me, I am sure he will give you the information.

213 X Q. Did you ascertain the amount of a mixture of pine tar oil and oleic acid referred to in one of my previous questions necessary to form a layer upon water in a test tube?

A. I have made an experiment with a mixture of these oils. The composition of the mixture had not been mentioned by counsel. As

I had only a very small quantity of pine tar oil left, I prepared the mixture of 75% of pine tar oil and 25% of oleic acid. The result was:

The layer on water done

In your way required ..... 0.75 cc.

The layer had then not been completely formed, but I had to desist because I had no more oil.

In the usual way ..... 0.2 cc

These experiments were made in the presence of Dr. Chandler. The result confirms my view that the usual method is the method to be used for such experiments. I had overlooked your request
847 to try this mixture of oils as expressed in X Q. 191, and when I discovered my oversight, made the tests and called it to your attention this morning.

214 X Q. In those operations wherein you repeated with a test tube and proportions adapted thereto, the slide machine operations of Dr. Byrnes described by him upon pages 165 and 166 of Defendant's printed record, how did you hold the test tube, that is, did you hold the tube in one hand and close it with the other hand?

A. It is very difficult to say what way one proceeds in these mechanical operations. They come naturally to one. I probably used both hands as you suggest.

215 X Q. Test tubes are made of very thin glass and of a quality of glass that will withstand heat without breaking, are they not?

A. They are comparatively thin, and they withstand heat.

216 X Q. You have given the price of crude sulphuric acid, brown oil of vitriol, I think you termed it, as $6.00 per ton? Will you please state the locality where this price prevails?

A. That is the price in England.

217 X Q. I presume it is the price at the Works where the acid is made?

A. It is the manufacturer's selling price.

218 X Q. You have stated that sulphuric acid is scarcely ever used for the generation of carbonic acid from limestone. Will
848 you state what acid ordinarily is used for this purpose?

A. My answer referred to the laboratory practice. The usual acid is hydrochloric acid.

219 X Q. Do you know whether hydrochloric acid is ordinarily used in the commercial production of carbonic acid?

A. I should say that the ordinary commercial production of carbonic acid would be carried out by the burning of charcoal. When the carbonic acid is used for the purpose of food as in carbonated drinks, it is usually produced from pure bicarbonate of soda and tartaric acid.

Cross-examination closed.

Redirect examination.

By Mr. Williams:

220 R. D. Q. In your answer to 184 X Q., you said you were not very definite as to the number of revolutions per minute which you had used when producing the agitation froth of the patent in suit in the cone mixer, and that you would later give definite information as to this point. Please now do so.

A. I have used the cone mixer at a speed of 1,200 revolutions and also at a speed of 1,600 revolutions for that purpose.

221 R. D. Q. In describing two tests made by you in carrying out the second process disclosed in the Everson patent, you have given the amount of oil used in cubic centimetres. For the information
849 of the Court, please compare these quantities with those specifically set forth in the Everson patent.

A. There is no ore specified in Everson's second example. I assume that she treated an ore of the kind mentioned in her patent, namely, an ore containing either gold, silver or copper, which she calls "precious metals," clearly not in the ordinary chemical sense, but for the reason of their great commercial value. I could, therefore, not draw any conclusions from the second process described in Everson's patent for the ore I used. The apothecary's measure "fluid drams" was not known to me, but I satisfied myself about it, and the quantities of oil used in my two experiments are in accordance with the quantities of the example. My chief guidance, however, for the second Everson mode of operation was the fundamental condition which she specified, namely, that the mixture of oil and mineral must be lighter than the gangue. The specified weight of the mixture of oil and mineral of the first example was 1.8, the specific weight of the gangue 2.5; the specific weight of the mixture of oil and mineral of the second example was 1.7, of the gangue 2.5.

222 R. D. Q. In describing tests made by you in accordance with the Froment description, you said that, in one instance, as to the experiment numbered 2, the minerals as they appeared on the surface had the look of a magma, and that in another instance, as to experiment numbered 3, the concentrate rose in the form of a magma to the top of the liquid. In other parts of your testimony you said that the result of the test tube example of the Froment patent was a magma consisting of oil, gas bubbles and mineral, while the
850 result of the process revealed by the Froment instructions was skin flotation assisted by gas bubbles. Have you anything further to say as to this?

A. In describing the result of the test made according to the instructions of Froment, I said that it looked like a magma, and it is true. Nevertheless, I did not intend to describe it as a magma. It is very difficult to draw the line between a thick mass of heavily oiled particles and floating oil containing mineral particles. The statement which I made that the result of the test tube example is a magma consisting of oil, gas bubbles and mineral, and that the result of the process revealed by the Froment instructions is skin flotation assisted by gas bubbles, is quite correct.

223 R. D. Q. The specifications of the Froment Italian and British patents state that the oil used in the test tube example is "ordinary oil." Please note that the Italian specification is dated May 20, 1902, the British provisional specification, which repeats this statement, was filed June 4, 1902. The British complete specification, which again repeats this statement, was filed March 4, 1903; also that the British complete specification states:

"This invention has reference to the concentration of metalliferous ores and earths for the purpose of separating and recovreing therefrom the finely divided metal or metallic compounds, and con-
851 sists of a modification of what is known as the oil process of ore concentration."

So far as possible returning to the conditions existing at the dates referred to, please state what, in your opinion, was the oil described by Froment in his patents as "ordinary oil."

A. The ordinary oil which is to be used according to the Froment patents can only be the oil which was used for the Elmore process, namely, a thick viscous mineral oil. Froment's specification says that his process is a modification of the process which was then known as the oil process of ore concentration. There was only one such process known, namely, the Elmore process, and for this process a thick viscous oil was a necessity. The "ordinary oil" mentioned by Froment clearly refers to such an oil. Oleic acid is not possible for Elmore's process. The oils and oil mixtures referred to in X Q. 191 are non-viscous oils, quite unsuitable for the Elmore process and this is equally true of the thin mineral oils which I tested. Two of the oils mentioned in X Q. 191 namely, wood tar oil and pine oil, are heavier than water and cannot reduce the specific weight of the minerals below the specific weight of water. Normally they are at the bottom of the water. The quantity of a heavy viscous oil, such as Elmore used, necessary to form the thinnest layer is 14.4 per cent. on the ore.

224 R. D. Q. You have given figures for the smallest
852 amount of oil to form the thinnest possible layer in a test tube such as Froment describes. What, in your opinion, is described in the Froment Italian and British patents as "a thin layer" giving your answer, in the dimensions of the thickness of the layer?

A. The term "a thin layer" of oil, used by Froment, is not definite. He does not say a few drops or the thinnest possible layer. I should say that a thin layer of oil, as expressed in the Froment specification, does not mean a layer of less than one-eighth of an inch thickness, but might mean more than that.

225 R. D. Q. In your tests in accordance with the Froment directions or instructions, it appears that you used an ore which had been crushed through a 60 mesh screen. I call your attention to the specific directions as to crushing which appear in the Froment description under the heading "B Instructions." Please state whether or not the fineness of ore used by you was in accordance with such specific instructions.

A. The standards mentioned by Froment are not known to me. The ore which I used was crushed by step crushing in such a man-

ner that, whilst the minimum of slimes was produced, there was at the same time a proper release of the minerals from the gangue. It will be remembered that it is necessary to de-slime for the practice of the Froment process revealed in the instructions.

226 R. D. Q. What would have been the result if you had ground the ore to, say, 80 or 100 mesh?

853 A. The result of such a grinding would have been a loss of about 50 per cent. or over 50 per cent. in slimes. The crushed ore has to be de-slimed, and it is to the interest of this process to avoid an excess of slime but yet to crush fine enough to release the gangue from the minerals.

227 R. D. Q. You say there would have been a loss of about 50 per cent. or over 50 per cent. in slimes. Would this be gangue slimes or valuable mineral slimes or both?

A. I should say it would be both.

228 R. D. Q. And as a general rule, what would be the proportion of valuable minerals in the slimes lost as compared with the proportion of the valuable minerals in the de-slimed ore?

A. I should say the proportion of mineral in the slimes would be about the same with the proportion of mineral in the ore.

229 R. D. Q. Where did you procure the samples of the oils, pinoline, pine oil and wood tar oil, and the sample of turpentine used by you in your tests described in answer to 204-X Q?

A. I procured the samples at one of the places named to me by defendant. I did not analyze them.

Redirect examination closed.

Deposition closed.

ADOLF LIEBMANN.

Adjourned subject to agreement of counsel, or new notice.

854 New York, December 9, 1912.

Met pursuant to agreement of counsel.

Present: Counsel as before.

Mr. Williams: The following documents are offered in evidence and each entitled "Complainants' Exhibit," followed by the words with which they are described in the following list:

British Patent 7803 of 1905;
Hoover Patent 953,746;
Hoover Patent 979,857;
Gabbett Patent 444,345;
British Boulton & Gabbett Patent 840 of 1889;
British Patent Haynes 488 of 1860;
Hebron Patent No. 474,829;
Robson Patent 575,669;
Cattermole Patent 763,259;
Cattermole Patent 763,260;
Wolf Patent 787,814;

British Patent Chapman 17,328 of 1906;
British Patent Minerals Separation, Limited, and Nutter, 23,870 of 1910;
British Patent Nutter, Hoover and Minerals Separation, Limited, 23,949 of 1910.

855 CHARLES F. CHANDLER, recalled as a witness in behalf of complainants, having been duly cautioned and sworn, testifies as follows:

Direct examination.

By Mr. Williams:

122 Q. Are you the same Charles F. Chandler who has heretofore testified as a witness for the complainants in this suit?
A. I am.
123 Q. Have you read all the testimony in the present suit?
A. I have.
124 Q. Please now give consideration to all documents which have been referred to as prior to the date of invention of the patent in suit, assuming that date of invention to be April 12, 1905, the day of the filing, with provisional specification, of the application for the British patent corresponding to the patent in suit, No. 7803, dated April 12, 1905. Please give first a classified list or summary of these various documents and thereafter briefly consider them in the order of their classification.
A. In summarizing the various documents, I have taken as my basis the summary made by Dr. Liebmann and printed in Complainants' Record, pages 533-536 and 543-545.
Dr. Liebmann separated the documents put in evidence by the defendant and referred to by defendant's expert, Dr. Byrnes, from those put in evidence by complainants as affording further ex-
856 amples of the efforts to solve the problem of ore concentration prior to the date of the invention which forms the subject matter of the patent in suit.
I have combined in one classified list all of these documents and have added to the list certain other documents so as to make a complete summary of the alleged prior art.
I have also given the dates of the various documents and I note that one of them, the application for the Schwarz patent, No. 807,501, was filed April 19, 1905, a week subsequent to the date of the invention in suit which I have been instructed to assume.

Summary of the Prior Art.

I. Apparatus.

1. Campbell Morfit Extract from Treatise on Chemistry Applied to the Manufacture of Soap and Candles, of 1860.
2. Wagner, No. 373,113 of 1887.

3. Boulton, et al., and Gabbett, British No. 840 of 1889.
4. Gabbett, No. 444,345 of 1891.
5. Elmore No. 653,340 of 1900.
6. Elmore No. 692,643 of 1902.
7. Stoveken, No. 729,805 of 1903.
8. Wolf, No. 787,814 of 1905.

857 II. Processes for Ore Treatment Without Oil.

1. Bradford, No. 345,951 of 1886.
2. Hockley, No. 466,753 of 1892.
3. Rouse, No. 469,599 of 1892.
4. Hebron and Everson, No. 471,174 of 1892.
5. Hebron, No. 474,829 of 1892.
6. Delprat, No. 735,071 of 1903.
7. Delprat, No. 768,035 of 1904.
8. Potter No. 776,145 of 1904.

III. Processes for Ore Treatment With Oil.

(*a*) Oil and Ore Mixed; Mixture Treated with Water.
Haynes, British No. 488 of 1860.

(a^1) Oil and Ore Mixed; Mixture Treated with Acidulated Water.
1. Everson, No. 348,157 of 1886.
2. Fryer Hill Publication of 1889.
3. Criley-Everson Publication of 1890.
4. Schwarz, No. 807,501 of 1905, Application filed April 19, 1905.
5. Schwarz, No. 807,503 of 1905, Application filed May 27, 1904.

(a^2) Ore and Water Mixed; Mixture Treated with Oil.
Robson, No. 575,669 of 1897.

(*b*) Pulp Treated with Oil; Concentrates Separated from Surface.

858
1. Elmore, No. 676,679 of 1901.
2. Elmore, No. 689,070 of 1901.
3. Glogner, No. 736,381 of 1903.
4. Good, No. 745,960 of 1903.
5. Kendall, No. 771,075 of 1904.

(*c*) Pulp Treated with Oil; Concentrates Separated from Bottom of Liquid.
1. Cattermole, No. 763,269 of 1904 (Classification).
2. Cattermole, No. 763,260 of 1904 (Emulsion).
3. Cattermole, No. 777,273 of 1904 (Granulation).
4. Cattermole, Sulman & Picard, No. 777,274 of 1904 (Soap and Granulation).

(*d*) Pulp Treated with Oil; Concentrates Floated by Introduction of Gases through Pipes or Generation of Gases in the Mixture.
1. Froment, Italian Patent No. 63,723 of 1902.

2. Froment British Patent 12,778 of 1902.
3. Froment Description and Drawings of 1903.
4. Cattermole, Sulman & Picard, No. 788,247 of 1905 (Soap and Flotation), Application filed March 29, 1904.
5. Sulman & Picard, No. 793,808 of 1905 (Bubbles), Application filed October 5, 1903.
6. Kirby, No. 809,959 of 1906, Application filed December 14, 1903.
7. Kirby, No. 838,626 of 1906, Application filed December 17, 1903.

859 I. Apparatus.

1. Campbell Morfit Extract from Treatise on Chemistry Applied to the Manufacture of Soap and Candles, of 1860. This publication discloses a twirling fan for agitating and aerating liquid soap, so that after it is hardened it will float upon water.

This twirling fan may perhaps be well adapted to aerate soap, but it is not well adapted to agitate a gritty ore pulp.

2. Wagner, Patent No. 373,113, November 15, 1887. This patent is for a churn designed to unite together the separate particles of butter fat in the cream so as to form a solid mass of butter distinct from the buttermilk. This patent suggests an advantage from aeration during churning, but the patentee is in error in his chemistry. Aeration is not desirable in churning cream to separate the butter. This churn is not well adapted for aerating gritty ore pulp.

3 & 4. Boulton, et al., and Gabbett, British Patent No. 840 of 1889, and Gabbett United States Patent No. 444,345 of 1891. The two patents are for the same invention. The U. S. patent refers to the British patent and the corresponding patents in Belgium and France. The invention was thus patented in the United States, Great Britain, Belgium and France.

The invention consists of a mixer for liquids or semi-liquids, in which a revolving cone is arranged in a vessel, which by reason of its shape or of the use of suitable baffles or other means, retards the rotation of the liquid.

860 The revolving cone develops centrifugal force, which tends to throw the liquid toward the larger end of the cone, thus effecting a circulation in the liquid which resists the rotation of the cone, and secures a very effective agitation or mixing. This apparatus is, therefore, a "cone mixer," and is the only cone mixer I know of. This cone mixer is diagrammatically shown in the patent in suit, and also in the three Cattermole patents Nos. 763,259, 763,260 and 777,273. The Gabbett patents show the details of construction of the cone mixer.

These details of construction include stationary baffles for retarding the rotation of the liquid.

The baffle details are not shown in the four other patents, except that in Fig. 2 of the patent in suit there is an outlet pipe a^1 standing vertically in the cone mixer, which performs the function of and is, in fact, a baffle. The three Cattermole patents referred to and

Fig. 1 of the patent in suit omit the baffle detail, but obviously it was not necessary to repeat the details already published and explained in the Gabbett patents.

In this connection, I note that, while the earlier advertising matter of the manufacturers of the Gabbett or cone mixer gives full detail drawings including the baffles, the later advertising matter omits the detail of the baffles. The advertisement in the Journal of the Society of Chemical Industry of November 30, 1897, was undoubtedly seen by me, as I have been a subscriber to this Journal for many years, ever since it was organized; in fact, at one time I was Presi-
861 dent of this Society. This Society is an international society, has had three American presidents, and the Journal has a wide international circulation.

This cone mixer is well adapted to thoroughly agitate and aerate an ore pulp, and is the apparatus disclosed in the patent in suit for effecting that part of the patented process.

5. Elmore Patent No. 653,340 of 1900. This patent, though put in evidence by defendant, was not explained by any of defendant's witnesses.

The general type of mixing device here disclosed has received some consideration in the testimony for complainants.

The apparatus of the patent was particularly designed to gently mix ore pulp and oil, so as to avoid aeration. The patentee says: "The ore and water and the oil, which are thus mingled without being broken up, so as to form a uniform mixture" (Spec. 653,340, page 1, lines 54-57).

The uniform mixture here referred to as something to be avoided, is an emulsion, such as would result from violent agitation, and which, with the large quantities of oil used in this apparatus, would defeat the object of the process in which the apparatus is to be used, to wit: the flotation of the valuable mineral of an ore by oil buoyancy.

The apparatus also includes a centrifugal separator for
862 recovering oil from the oil-floated concentrates. From this centrifugal (*h*, Fig. 2), the separated oil is drawn up through the pipe *q* to the cistern *o*, in which a partial vacuum is created so as to remove any air bubbles which may have become incorporated in the oil. Some slight aeration might result from the action of the centrifugal separator. The patentee says:

"in order to clear the oil from air-bubbles, I prefer to draw the oil up to the cistern by creating a partial vacuum in the cistern" (Spec. 653,340, page 1, lines 88-91).

It is also suggested that instead of employing centrifugal force to separate the oil from the oil-floated concentrates, the oil may be separated by first heating it or thinning it with benzoline and allowing the concentrate to subside, or subjecting it to filter pressing. It is notable that the oil which is to be used is a very thick and viscous oil, compared to which oleic acid is a very thin oil. The oil is described as follows:

"The thick oil which I employ is the thick tarry residue, usually called 'residuum,' of mineral oil after some of the more volatile constituents have been distilled off" (Spec. 653,340, page 1, lines 24-28).

This, therefore, is an apparatus for oiling a pulp with great quantities of oil so as to avoid aeration, for recovering so much of the oil as practicable from the concentrate, and for removing any bubbles of air which may possibly have become commingled with the oil.

863 Obviously the apparatus is entirely unsuitable for briskly agitating and aerating an ore pulp, such as is necessary for the purposes of the patent in suit.

6. Elmore Patent No. 692,643 of 1902. This patent discloses another variety of mixing apparatus for use in the Elmore bulk oil process. This patent also was put in evidence by the defendant, but was not explained by defendant's witnesses.

The apparatus consists of a trough, through which extends a horizontal shaft carrying screw-propeller blades which act to mix the oil and pulp, and propel it toward the exit end of the apparatus. The description of the apparatus is very brief. The patentee says:

"As the liquid mineral pulp and oil are caused by the blades *c* to travel along the trough *a* they become thoroughly mixed, and the mixture issues by an opening *f* into a subsidence-tank *g*" (Spec. 692,643, page 1, lines 25-29).

I also refer to the companion patent No. 689,070 for a description of the operation. Here the patentee says:

"The liquid mineral pulp, oil, and acid are caused to travel along the mixer A and become thoroughly mixed" (Spec. 689,070, page 1, lines 82-85).

The apparatus also includes a centrifugal separator for recovering the oil.

This corresponding process patent No. 689,070 merely adds to the earlier process patent the use of acid.

864 It clearly states the function of the oil to entrap and float the mineral. The apparatus is, therefore, designed to mix, not to aerate, and is well adapted to mix a great quantity of oil with an ore pulp, and distribute the oil in contact with the valuable mineral, so that the mineral will be entrapped and floated by the oil in the next, or subsidence vessel. For this purpose, the blades should be revolved at a comparatively slow speed. High speed would defeat the object of the apparatus. The apparatus is a good mixer when aeration is not desired, and when considerable quantities of oil are used. It would be an entirely inefficient device if an attempt were made to use it for the purposes of the patent in suit.

7. Stoveken Patent No. 729,805 of June 2, 1903. Here we have a mixing device for use in a cyaniding process. Aeration is here desirable to accelerate the chemical action, but not by any means for the purpose of producing a froth. Wings *j* or baffles are provided which the patentee says will roll back the pulp to the center of the tank. This the patentee says,

"is materially advantageous, since in addition to being kept in suspension the material is worked up and down, and consequently the

cyanide solution is caused to absorb the necessary oxygen and effect a rapid and complete dissolution of the gold and silver contained in the ore" (Spec. 729,805, page 3, lines 2-8).

865 It is very evident that this apparatus is not designed for the high speed that would be required if an attempt were made to use it for the purposes for which the agitating apparatus is used in carrying out the process of the patent in suit. Nevertheless, if it were materially strengthened, it would probably do very well. It might possibly be made use of, if more rigidly and strongly built, by a metallurgist to whom the invention of the patent in suit had been disclosed, as a modification of the agitating apparatus disclosed in the patent in suit.

8. Wolf Patent No. 787,814 of April 18, 1905. Although this patent was issued six days after the date of the invention of the patent in suit which you have asked me to assume, I note that the application was filed May 22, 1903. The mixer B shown in the upper left hand corner of the drawings is described by Mr. Sulman as the well known Johnson mixer purchased from a London manufacturer of that name. The operation of this mixer is evidently very similar to that of the cone mixer and I should be much inclined to characterize the apparatus as representing an effort to get the effect of the cone mixer without infringing the Gabbett patent. Instead of the revolving cone, which moves the liquid up or down by centrifugal force, we have a stationary cylinder, and a turbine wheel B 2 below the open end of this cylinder which operates to move the liquid up or down in the cylinder, thus effecting substantially the same circulation as in the cone mixer. Radial arms supporting the inner cylinder act as baffles to retard the movement of the liquid.

866 This is evidently a very good mixing apparatus, and, if operated at sufficiently high speed, would aerate the liquid. It was clearly not so operated in the Wolf process. After the publication of the patent in suit, a metallurgist might well use this Johnson mixer as a modification of the mixer and agitating apparatus disclosed in the patent in suit.

This patent, although I have classified it in apparatus, discloses a process which has been referred to in the testimony as the Wolf or Scammel process. Mr. Chapman briefly describes it in answer to 134 X Q. at page 207 of Complainants' Record. Mr. Ballantyne also refers to it and its total failure (Complainants' Record, pages 271,272). The process is a modification of the Elmore oil flotation process, and does not in any manner resemble the process of the patent in suit. Aeration must be avoided in the mixing and separating. After the separation of the values from the gangue has been completed, the worthless residues are submitted to a treatment to recover the oil from them, this treatment consisting in blowing air through them to separate and float the oil.

General Remarks on Apparatus. There are other documents which disclose apparatus, but it would not be worth while to discuss them under this heading. Some apparatus is necessary to carry out any process, whether the apparatus be the simple test tube of the

laboratory, or more elaborate apparatus known to the chemist or metallurgist, or special apparatus designed for the particular process. Process and apparatus are usually distinct inventions. The patent in suit is for a process. To dwell too much upon apparatus would tend to confuse the issue.

II. Processes for Ore Treatment Without Oil.

867 1. Bradford Patent No. 345,951, of July 20, 1886. This patent has been sufficiently explained. It depends upon flotability by surface tenison. It lacks any positive means for differentiating the valuable mineral from the gangue and is open to the serious objection that, in some instances, it is as apt to recover gangue as it is to recover valuable mineral, and, therefore, the recoveries are not usually concentrates.

I note from Mr. Ballantyne's deposition (C. R., page 276) that the patentees of the patent in suit, Messrs. Sulman, Picard and Ballot, without knowing of the Bradford patent, worked out a similar process and gave it a thorough trial and abandoned it as worthless.

2. Hockley Patent, No. 466,753 of January 5, 1892. This patent does not disclose a process for concentrating ores and has really no place in the present classification. The invention consists of an apparatus for sliming ores. Its aim is to recover exceedingly finely divided metallic gold or silver, bringing them to the surface of a body of water by an up-current and retaining them there by surface tension. It is not remotely related to the invention of the patent in suit, and if of any practical value, which it does not appear to be, would never be used as an auxiliary even to the process of the patent in suit, because the process of the patent in suit is unique in that it concentrates and saves all slimes. No one ever did this
868 before in a process of ore concentration except Cattermole, and Cattermole's process, as appears in evidence, was immediately abandoned with hardly a practical trial when the invention of the patent in suit was made.

3. Rouse Patent No. 469,599 of February 23, 1892. This is another process for saving something from the slimes which are usually wasted. It is not a concentration process at all. It simply provides for carrying fine particles to the surface and floating them there by surface tension. It is no nearer to the invention of the patent in suit than Bradford or Hockley.

No oil is used, no agitation, no acid and the floating material is as apt to be gangue as valuable mineral.

It may be possible that a few bubbles, when they reach the surface, do not burst, but it is certainly true that most of them do when they reach the surface, and the others shortly thereafter.

4. Hebron & Everson, Patent No. 471,174 of March 22, 1892. This is the second patent of the Everson series, and marks the abandonment of the use of oil to assist in floating the mineral.

It is founded upon the notion that material can be pressed into

cavities between the atoms of a molecule of metalliferous matter. This is absurd.

5. Hebron Patent No. 474,829 of May 17, 1892. This is stated to be an improvement upon the Hebron & Everson patent last considered, the improvement consisting in heating an ore so as to
869 drive the air out of its alleged pores between the atoms of the molecules and forcing in buoyant material, by pressure, and then aerating the surface. After this has been done, the effort is made to float it.

This is the last patent of the Everson series. Carrie J. Everson was one of the patentees as the assignee of a part interest. It marks a sad ending of an enterprise which started with real genius.

Carrie J. Everson discovered the great assistance to ore separation by oil which was effected by the use of an acid, but she worked this out in an utterly impracticable bulk oil process. The cost of oil was prohibitive. Instead of discovering the possibility of the utilization of a minute quantity of oil, she abandoned oil, and the enterprise ended in these two ridiculous patents founded upon altogether untenable theories of molecular construction.

6 and 7. Delprat Patents No. 735,071 of August 4, 1903, and No. 768,035 of August 23, 1904.

8. Potter Patent No. 766,145 of November 29, 1904.

These three patents will all be considered together. They disclose processes for generating gases in an ore pulp by the action of acids, nitric or sulphuric. The gas utilized is probably carbonic acid gas, although Delprat, in his second patent, and Potter speak of sulphuretted hydrogen. The gas is supposed to select the metallic particles and float them to the surface, producing a tender float. This Dr. Byrnes illustrates in his illustrative Experiment 4, described on page 159 of Defendant's Record. No oil is used and there is no aeration by agitation.

870 General Remarks on Processes not Using Oil. These proposed processes, in which no oil was used, are of interest as showing the activity of inventors during a period of twenty years from 1885 to 1905. In considering the processes which used oil, it will be found that the Everson patent, the application for which was filed August 29, 1885, and which uses a great amount of oil, and which is altogether out of question because it uses so much oil, was at the beginning of this period. The process of the patent in suit was invented, according to the date that I am to assume, on April 12, 1905. The eight patents above explained appeared successively at different times during this interval. They may all be taken as efforts to save the expense of oil. Two of them were further developments of Everson, but with the abandonment of oil. Not one of them discloses the process of the patent in suit and they do not lead to or suggest the process of the patent in suit. They are evidence of the desirability of the object which was attained by the process of the patent in suit, and they show that many other inventors worked with the same object, but utterly failed and missed the invention.

III. Processes for Ore Treatment With Oil.

(*a*) Oil and Ore Mixed; Mixture Treated with Water. Haynes British Patent No. 488 of 1860. This patent discloses a process of ore separation in which powdered ore is mixed with an agent
871 composed of substances not soluble in water, one class of these substances being fatty or oleaginous matters. It may be said generally that he describes the making of a mixture which would be a stiff paste and then triturating in water to wash out the gangue. A procedure is also described for removing the agent from the metal.

It should be noted that for sulphurets, for which the patent in suit is especially adapted, Haynes does not use any oily or fatty matter in conjunction with his bituminous combination of coal tar, resin, etc.; and further that his proportions of bituminous agent are very large, from one to five of ore (20 per cent.), to one to nine of ore (11 per cent.). The name "sulphurets" is the old name for sulphides.

Adjourned to Tuesday, December 10, 1912, at 10:30 in the forenoon, at the same place.

New York, December 10, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Direct examination continued:

(Answer to 124 Q. continued:)

(a^1) Oil and Ore Mixed; Mixture Treated with Acidulated Water.

1. Everson Patent No. 348,157 of August 24, 1886. This patent discloses two methods of treatment. The first is altogether impracticable and has not been commented upon by Dr. Byrnes.
872 A compound is made of sulphuric acid, cottonseed oil and water and mixed with the ore so as to produce a stiff mass or pudding. I have tried this with indifferent results.

The second method I have also tried. This Dr. Byrnes says he has tried, but the procedure which he adopted is not warranted by the Everson disclosures. His test as described on pages 163 and 164 of Defendant's Record resembles the Everson procedure only in the quantities of materials used. In all other particulars he uses the knowledge of today and by repeated agitation in the slide machine, without oil additions, and by removing his floating material as fast as it is formed, he reduces the amount of oil in each successive treatment and, as there were nine successive treatments, he probably had removed the greater part of his oil before the last treatment.

I carried out the instructions of the Everson patent as to the second method of treatment described therein in the following manner: I took 16 oz. of defendant's ore, crushed so as to pass through an 80 mesh sieve, and 24 drams of petroleum, and mixed the same thor-

oughly in a porcelain mortar. The result was a damp sand resembling molding sand. I then prepared some acidulated water by adding 8 drams of oil of vitriol to four gallons of water, the above being the proportions suggested in the Everson specification. I then put the ore, mixed with petroleum, in a slide machine with 1700 cc. of the acid water and agitated thoroughly for two minutes.
873 On stopping the agitation an oily mess appeared on the top of the water in the machine.

I then ran the contents of the slide machine, while the agitation was continued into a washing out vessel, in which there was an upward current of acidulated water with constant overflow. The result was concentrates 119 grams, tailings 255 grams. There was little difference between them. There seemed to be little more valuable mineral in the concentrates than there was in the tailings. Some of the material remained behind in the slide machine. The separation was a complete failure.

This Everson patent is of interest as containing the first disclosure of the use of an acid in connection with oil to prevent the oil from attaching itself to the gangue. This was an important step forward in the art, but the amount of oil used in the Everson patent was prohibitive. Apparently an attempt was made to use this process with silver and gold ores, but even with these ores the process appears to have been a failure, as it has only been heard of in connection with two published experiments, which I shall now consider.

2. Fryer Hill Publication of 1889. This article in the Daily Herald Democrat, of Leadville, Colorado, dated October 30, 1889, describes an effort to use a process resembling the Everson process on silver ores. Petroleum is the oil used and the water is acidulated with sulphuric acid. Steam is used to heat the mixture and in this respect the Everson process is improved upon. An upcurrent in the agitator causes the mineral-charged oil to be carried to the
874 surface, where it is trapped by closing two semi-circular doors beneath it, and then the mineral-laden oil is removed to settling barrels. The newspaper report is quite enthusiastic and says that there are thousands of tons of this ore awaiting this treatment. Apparently nothing more was heard of this effort to use the Everson process with silver ores.

3. Criley-Everson Publication of 1890. This article in the Engineering & Mining Journal of November 15, 1890, describes what appears to be a laboratory test of the Everson process with a gold ore of the Eureka & Excelsior Gold Mining Company. A black thick oil and acidulated water heated nearly to boiling are described as having been used. The description reads like that of an Elmore bulk oil flotation experiment.

This is the last that was heard of the Everson process as an oil ore concentration process. In the subsequent patents of the Everson series, no oil is used. These are the Hebron & Everson patent, No. 471,174 of 1892 and the Hebron patent issued to Carrie J. Everson as one of the assignees, No. 474,829 of 1892. I considered these two patents in their proper place and commented there upon the fact that they indicated that the great expense of the large quan-

tities of oil used in the Everson process was overcome by abandoning altogether the use of oil.

4 and 5. Schwarz Patents Nos. 807,501 and 807,503 of December 19, 1905. The application for the first of these patents was filed April 19, 1905, and it is, therefore, too late to be considered as a prior document to the application for the British patent cor-
875 responding to the patent in suit, filed April 12, 1905. This document is, therefore, very nearly contemporaneous with the first official document disclosing the invention of the patent in suit. It discloses what is clearly a bulk oil flotation process and the injection of air or gas to give a certain sponginess to the mass of oil carrying the mineral so as to increase the floating power of this mass of oil and mineral.

The second Schwarz patent, No. 807,503, was issued on an application filed May 27, 1904, and is, therefore, to be considered as a prior document. This also is a bulk oil flotation process, in which the mineral is entrapped in and floated by the oil. Oil is used in sufficient quantities to make with the ore a thick pasty mass, which is first mixed without any water and then mixed with water.

"The mass is then allowed to subside, when the selective material with the entrapped metallic constituents of the ore, will rise to the top and may be removed in any suitable manner, as by floating over the top of the vessel" (Spec. 807,503, page 1, lines 65-69).

The selective material is oil. During the first mixing, air or gas is blown in to give the thick pasty mass a certain amount of sponginess. After the admission of water the blowing of air, steam or gas may be continued.

Dr. Byrnes describes on pages 162 and 163 of Defendant's
876 Record an alleged Schwarz test, but as he only used sufficient oil to give the mixture of oil and ore the consistency of molding sand, which is a slightly damp sand, it is quite certain that he did not follow the directions of Schwarz and did not produce a thick pasty mass of such consistency that it would acquire sponginess when air was blown in it.

I carried out this Schwarz process in accordance with the directions of the patent in a test which I will now describe.

As Schwarz states in the second patent that he prefers crude petroleum or any of its products, to which is added about 9 to 10 per cent. by weight of paraffin, I prepared the following mixture: 90 grams of crude petroleum, in which I dissolved 10 grams of paraffin wax. I then weighed out 300 grams of defendant's ore, crushed so as to pass through an 80 mesh sieve, and mixed it with the petroleum and paraffin. The whole formed a thick paste. This I put into the slide machine, pumped air in at the bottom, and kept the agitator going slowly. There was not enough material to keep the agitator covered. The material, was so thick that it piled up at the sides and corners, and the air, which was blown in underneath it through a perforated coil, made channels at one or more points and then blew through these channels without aerating the mixture. I, therefore, decided that a greater proportion of oil was

necessary, and material enough to well cover the agitator, so I added
300 grams additional ore and 200 grams of the mixture of
877 paraffin and petroleum, the result being 600 grams of ore
and 300 grams of the mixture of paraffin and petroleum, the latter amounting to 50 per cent. of the weight of the ore. I then continued the agitation and the injection of air.

I next injected water under pressure, continuing the agitation and adding 2 cc. of sulphuric acid, and also continuing the injection of air. There was produced a floating mass on the top of the contents of the machine about one-half an inch thick, mainly oil, with some air bubbles and some mineral, but with considerable gangue. On examining the tailings I found them full of oil and of minerals. The process was a complete failure.

Schwarz got very little further than Elmore in oil economy. The process does not appear to be of any practical value whatever and is very far removed from the process of the patent in suit.

(a^2) Ore and water Mixed; Mixture Treated with Oil.

Robson Patent No. 575,669 of January 19, 1891. The process here disclosed is unique, in that the ore is brought into a moist condition by the admixture therewith of a small quantity of water, from 25 to 35 per cent., and an attempt is made to wash out the mineral with oil in a mixing vessel in which the "mud or mass" is to be
brought into intimate contact with the oily liquid. The
878 quantity of oil used in such a process would, of course, be enormous and prohibitory.

(b) Pulp Treated with Oil; Concentrates Separated from surface.

1 and 2. Elmore Patents No. 676,679 of June 18, 1901, and No. 689,070 of December 17, 1901. The second of these patents differs from the first only in that acid is added to the ore pulp.

Both are bulk oil flotation processes in which a great quantity of oil is used, which acts to entrap the mineral and float it to the surface by reason of the fact that the specific gravity of the mixture of oil and mineral is less than that of water.

Brisk agitation must be avoided because it would tend to make a uniform mixture or emulsion, which would prevent the separation. An effort is made to save some of the oil by treatment in a centrifugal machine or by a filter press, and the recovered oil is treated to an air withdrawing operation, so as to remove any air bubbles that may possibly have gotten into the oil.

Dr. Byrnes very properly says (D. R., page 204) of the four Elmore patents, two for apparatus and two for processes, all of which I have considered, that they

"relate to the flotation of mineral by oil per se rather than gas."

And also that

879 "The flotation processes described therein do not rely on aeration or the evolution of a gas."

It is in evidence that these Elmore processes were tried in practice and long since abandoned, and this I can well understand, since the loss of oil, with all the efforts made to recover it, would be very

much greater than the amount of oil used in the process of the patent in suit.

I have made several tests of the Elmore process. The amount of oil with Broken Hill ore required for carrying on the process would be about 6,000 pounds of oil for a short ton of ore. This is not all used at once, and a reasonable way of carrying out the process would be to use 100 per cent. of oil at a time as described by Mr. Chapman on page 205 of Complainants' Record.

I carried this out in practice and measured the thickness of the oil layer which constituted only 100 per cent. of the ore. This layer was one inch in thickness in a large test tube, and a trifle under one inch in thickness, in fact, 15/16ths of an inch, in a glass cylinder about three inches in diameter.

3. Glogner Patent No. 736,381 of August 18, 1903. This is the first of the graphite patents and describes a bulk oil flotation process for separating graphite from gangue. The oil used is petroleum and the quantity used is about half that of the graphite contained in the ore. The mixing vessels are suspended pots, "preferably operated by human force" at the rate of thirty shocks per minute, or
880 one every two seconds. Dr. Byrnes theorized on this process, but apparently has not tried it in practice. He says that the agitation of these swinging vessels will intermingle with the pulp a large amount of air,

"just as an ocean wave entangles air and forms a floating froth or foam" (D. R., page 130).

Again at Defendant's Record, page 170, he says:

"Glogner 736,381 illustrates an oscillating, agitating vessel, in which the mixture of ore pulp and water is thrown violently against one end of the vessel, the wave falling back through the air, thus imitating aeration and frothing produced by an ocean wave."

I tried this out in practice. Not a particle of froth or foam was formed. The graphite floated to the surface entrapped in an oil layer, which was remarkably smooth. Instead, however, of using a swinging vessel, I used a bottle. Mr. A. Howard Higgins supplied the human force, and very vigorously shook the bottle at the rate of thirty sharp shocks per minute.

4. Good Patent No. 745,960 of December 1, 1903. This is really an apparatus patent for treating graphite in a bulk oil process. The apparatus and its operations have been fully described by Dr. Liebmann and I shall not repeat his description, as the patent discloses nothing having any relation whatever to the process of the patent in suit.

881 5. Kendall Patent No. 771,075 of September 27, 1904. This is the third and last of the graphite patents. It describes a process for treating graphite or graphite waste with kerosene oil or "paraffin oil," as it is called in England,

"which adheres to and by reason of its levity separates the graphitic substances" (Spec. 771,075, page 1, lines 14-16).

This is clearly a bulk oil process in which the mixture of oil and graphite must be light enough to float on the surface of the water. This is true of the three graphite processes which I have considered and they are no nearer to the process of the patent in suit than is the Elmore bulk oil buoyancy process.

(*c*) Pulp Treated with Oil; Concentrates Separated from Bottom of Liquid.

1. Cattermole Patent No. 763,259 of June 21, 1904. This is the Cattermole classification process for separating granules of mixed sulphides obtained by the Cattermole process or breaking down the granules. This is really a supplement to the Cattermole process, and not in itself an ore concentrating process.

2. Cattermole Patent No. 763,260 of June 21, 1904. This is the emulsion patent, and is a division of the application for the Cattermole granulation patent next to be considered, and everything described in it is also described in that patent, which I will now consider.

882 3. Cattermole Patent No. 777,273 of December 13, 1904. This is the granulation patent and constitutes the next real step forward in the art after the Elmore patents.

A great reduction is made in oil quantities from those used in the Elmore process. Instead of 6,000 lbs. of oil to the ton of ore, we have a recommended proportion of from four to six per cent. of the weight of the metalliferous mineral present in the ore, which, with Broken Hill crude ore, which contains about 50 per cent. of mineral, would be 2 to 3 per cent. on the ore. With Broken Hill tailings containing about 30 per cent. of mineral, this recommended percentage would be 1.2 to 1.8 per cent. on the tailings, which in this instance would be the ore.

It is very evident from this patent that the process is not adapted for use with lean ores since there is a caution to increase the amount of mineral if there is but little mineral present in the ore.

The fundamental idea of this patent is the production of agglomerated masses having sufficient falling power in water to enable the gangue to be carried upward away from the mineral by an up-current of water, the mineral falling to the bottom of the up-current vessel.

No amount of juggling with figures can make this a flotation process. Dr. Byrnes appears to have finally convinced himself that the process of this Cattermole patent

883 "is one of oil-gas flotation" (Def. Rec., page 214).

This conclusion is so greatly at variance with the disclosures of the Cattermole granulation patent that it seems incomprehensible that it could have been reached even as a result of pure mathematics dissociated from actual tests.

I have tested this Cattermole process and have obtained results such as this patent describes. The process is extremely interesting, and if the process of the patent in suit had never been invented, it might have been useful to-day.

It is in evidence, however, that it was immediately displaced by

the process of the patent in suit after a short trial, in which the oil consumption alarmed the mine owners, and efforts were made to reduce the oil consumption (Chapman Deposition, C. R., page 174).

4. Cattermole, Sulman & Picard Patent No. 777,274, of December 13, 1904. This is the first of the so-called soap patents, and is known as the Soap and Granulation patent. It discloses granulation according to the Cattermole process with the use of soap, which is a compound of oleic acid and soda, and which is decomposed into oleic acid and soluble sodium sulphate by sulphuric acid. The process described is the granulation process with this modification as to the oily material and the method of obtaining it.

881 I note that Dr. Byrnes succeeded in convincing himself by mathematical computation that this patent was, like the Cattermole patent No. 777,273, one of oil-gas flotation (Def. Rec., page 214). I quote from the patent as follows:

"This process may conveniently be rendered continuous by feeding ore-pulp, soap solution, and mineral acid continuously into one or more agitating vessels and discharging the products of agitation into an up-current separator, which allows the metalliferous granules to fall to the bottom of the vessel, while the particles of gangue are carried away by an upward stream" (Spec. 777,274, page 1, lines 66-74).

It is very evident that Dr. Byrnes had forgotten the language employed by the patentees when he reached his remarkable conclusion.

Adjourned to Wednesday, December 11, 1912, at 10:30 in the forenoon, at the same place.

883 New York, December 11, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Direct examination continued:

(Answer to 124 Q. continued:)

(*d*) Pulp Treated with Oil; Concentrates Floated by Introduction of Gases through Pipes, or Generation of Gases in the Mixture.

1. Froment Italian Patent No. 63,723 of 1902. The specification of this patent is dated May 20, 1902. The specification starts with a statement of four phenomena studied by the inventor which are stated to have served as a basis of the process which forms the subject of the invention. The four phenomena are then briefly stated and are followed by a statement of a test tube example, in which proportions are given or indicated and agitation for a period of a second is directed. This test tube example, when performed as directed, results in the flotation of a magma or paste of oil and mineral with gas bubbles in it. After the description of the test tube test, the patentee says:

"Such is the principle."

Then follows as example 1, a description of an ore and a statement that only a few seconds are necessary for completely separating

the sulphide of one of the metals from the rest of the gangue.
886 This means, of course, the complete operation of agitation and subsidence. Then follows, as Example 2, a brief description of another ore and a statement that it had been treated in the same manner and with the same success.

It will be noted that we have here no description of any process except a process carried on in the simplest laboratory apparatus, to-wit: a test tube. That process appears to be workable in that apparatus. I have tried it and have obtained fair separation of the metals from the gangue. Possibly if I had the same ore Froment had, I might have come nearer to the complete separation which he describes.

I have said the proportions are either given or indicated. The weight of the ore, 10 grams, of the limestone, one gram, and the water 30 grams, are precisely stated. The amount of sulphuric acid is stated as a few drops. This is indefinite. Certainly the sulphuric acid has to be used with caution, as it effects a gas generation reaction, which, if too violent, will expel the contents of the test tube, but the caution of the specification is against excess of limestone, not excess of sulphuric acid, and one gram of limestone would require one gram of sulphuric acid, concentrated, for its complete decomposition. This would be about 26 drops from a bottle, or 32 drops from a pipette with a small opening, or 23 drops from a pipette with a large opening.

887 The quantity of oil is specified as a thin layer. The kind of oil is specified as ordinary oil. The ordinary oil of the oil process of ore concentration known at that time, to-wit: the Elmore bulk oil buoyancy flotation process, was thick residuum oil. The layer in a test tube of this Elmore process, using the minimum quantity of oil for such tests, is at least an inch thick. It appears in the testimony of Mr. Ballantyne (Complts.' Record, page 308) that this Elmore process was in use at the mines in Traversella, Italy, where Froment was engineer. Therefore, in my opinion, it is a reasonable interpretation of the meaning of the statement "a thin layer of ordinary oil," that a layer from an eighth of an inch to a quarter of an inch in thickness of thick residuum oil is described.

The thinnest possible layer of this thick residuum oil requires a quantity of oil 11.7 per cent. of the ore, 42 drops, equivalent to 1.3 cc., but Froment evidently did not mean to describe the thinnest possible layer, but only a layer which would be thin as comparable with the inch thick layer of Elmore.

The time of agitation is definitely stated. The mixture is to be agitated for a second, as the reaction generating the gas is an instantaneous reaction and the gas will escape if the agitation is continued for anything more than a brief space. This explicit direction to agitate for just one second is reasonable and what I would expect.

888 I have obtained a floating magma containing a fair proportion of the mineral by agitation for one second and have then destroyed or greatly diminished the float by agitation for a few seconds more. Froment had but one idea, and that was to float the mineral by carbonic acid generated chemically, and he has

disclosed in this patent a very interesting and fairly effective test tube operation, which, if carried out in accordance with his directions, is successful, but which, with a too long agitation, fails because of the escape of the generated and liberated gas.

As I said, the only procedure described in the patent is the test tube operation. It is rather surprising to read at the end of the specification that there are several distinct, but connected operations in the practical working of the process. The only working that has been described is a test tube operation, which is certainly not a practical working. These operations of a practical working process which have not been described are then set forth and I will enumerate them with exact quotations:

(1) "The formation of the spherules and their separation from the gangue."

(2) "Then separation of the concentrates and the oil and recovery of this latter for re-entrance into the circuit of operations."

The part which I have numbered (2) has not been heretofore described, but it was a well known step in the Elmore process and probably the inventor deemed it unnecessary to describe it. He says:

889 "The products of the concentration form oil cakes."

This indicates that the oil is recovered in a filter press, as suggested in the Elmore patent No. 676,679. As such procedure does not recover all the oil, his statement is quite accurate. His concentrate would be in the form of oil cakes, the particles of the concentrate adhering together by reason of the oil left in contact with them.

The claim gives a little further description of the oil. It is stated to be

"an oily fat body,"

and it is stated not to be

"an oily body derived from bitumens, tar, naptha, etc."

This excludes wood tar, coal tar and all their derivatives, such for example as pine oil, sweet pine oil and wood tar oil. It also excludes all essential oils, such as eucalyptus and turpentine, since they are not fatty oils. It excludes the lighter distillates of petroleum, naptha, etc., but thereby includes thick residuum oil. Whatever he had in his mind, he describes a thick oil and as petroleum residuum was then used in the art as the ordinary oil for concentrating ores, I think it is evident that he meant to describe this petroleum residuum.

890 2. Froment British Patent No. 12,778 of 1902. The date of the application, with the provisional specification, of this patent, is June 4, 1902, which is about two weeks later than the date of the Italian specification. The patent was applied for and issued to Henry Harris Lake, of the well known firm of Haseltine, Lake & Company, London, patent agents, as a communication from Froment. The provisional specification is almost an exact literal translation of the Italian specification, except for the absence of the claim,

and provisional specifications do not contain claims. The slight changes are such as one would expect from a translator who is a British patent agent. The statement as to the period of agitation, which in the Italian specification is "a second," appears in the British specifications as "a brief space."

The statement of the Italian specification that the products of the concentration form oil cakes, becomes in the British specification that the products of concentration form cakes. Other slight verbal changes are unimportant.

The British complete specification, which appears to have been filed March 4, 1903, repeats the provisional specification except for the opening statement that the invention is now "particularly described and ascertained" and the reference to what is known as the oil process of ore concentration, of which this invention is stated to be a modification, and except also for the claim at the end of the British complete specification, which is quite different from
891 the Italian claim and suggests a process in steps: (1) mixing the finely powdered ore with water; (2) adding a suitable oil; and (3) then liberating a gas in the mixture. There is no reference to squeezing out the oil from the concentrates in this claim and very properly, because this was old in what was then known as the oil process of ore concentration, to-wit: the Elmore bulk oil buoyancy flotation process.

The only definite disclosure of either of these patents is of the test tube operation. The remainder of the patents is theory and speculation. Each patent itself describes the only definite disclosure in it as an example of the principle, and the Froment patents are, in fact, patents for a principle, not worked out into any practical or useful process.

I have made a number of test tube tests according to the test tube operations described in the Froment patents, and departing from it in the use of other oils which were used by Dr. Byrnes in his tests alleged to have been according to Froment, but substantially different from Froment in every instance. Two of my tests are as follows:

Experiment 1. I took 10 grams of defendant's ore, crushed to pass through an 80 mesh sieve. To this I added one gram of pulverized calcite (carbonate of lime), 30 cc. of water. I agitated them sufficiently to moisten the ore and the calcite and mix them to-
892 gether. I then put five drops of oil of vitriol into the tube and a layer of Winter dark oil, just sufficient to cover the surface of the water, which amounted to 1.3 cc. I then gave it five shakes, which occupied one second, and on allowing it to stand for a moment, a magma rose to the surface which measured a vertical inch in thickness. The tailings at the bottom of the tube were fairly clean. I then shook the test tube another second. The magma diminished and measured less than one-half an inch, and the tailings appeared darker from the subsidence of some of the metallic particles. I then shook it another second, and the magma diminished to one-fourth inch. I then shook it another second and the magma diminished still further and the tailings became quite dark. I then

shook it another second, and the magma remained about the same, but was nearly all oil.

Experiment 2. I took the same ore that I used in Experiment 1, 10 grams, limestone 1 gram, water 30 cc., agitated sufficiently to wet the ore and limestone, then added 1.6 cc. of oleic acid comparatively pure, 5 drops of oil of vitriol, agitated for one second. The result was a good half inch of magma. I shook it five seconds more and nearly all the magma disappeared, the mineral matter going to the bottom. Nothing on the top but a few clean bubbles and a little mineral floating by surface tension.

The following experiments are Dr. Byrnes' slide machine tests translated back to the Froment test tube tests.

893 Experiment 3. I took 10 grams defendant's ore, same as before, 30 cc. of water, one drop cottonseed oil, and 7.4 cc. of 1/10 normal sulphuric acid, equivalent to 0.036 gram of sulphuric acid; shook for one second; result, no separation of mineral and no flotation. Shook the tube for 8 seconds longer; the result was a little collection of bubbles on top containing a slight amount of unseparated slimes. There was no separation of minerals from the gangue and the experiment was an absolute failure. This was a translation of Dr. Byrnes' first experiment, page 165 of Defendant's Record.

Experiment 4. Experiment repeated, substituting 0.4 cc. of cottonseed oil for the one drop of cottonseed oil in the previous experiment; everything else the same. Shook for one second, practically no separation of mineral from gangue; some bubbles on top; no mineral, only a little unseparated ore. This is Dr. Byrnes' second experiment, page 165 of Defendant's Record, translated from the slide machine to the test tube.

Experiment 5. This was the same as Experiment 4, with the substitution of 0.4 cc. of olive oil for the cotton seed oil of the previous experiment. Shook one second, no mineral separation, few bubbles on top with a little unseparated ore.

Experiment 6. Experiment as before, except 0.4 cc. of defendant's red oil was used, previously warmed slightly to make it thin,

894 as room was sold; shook for one second; no mineral separation; few bubbles on top quite clean, and very little unseparated ore.

Experiment 7. Same as before, with the substitution of Hegeman's comparatively pure oleic acid, 0.2 cc., half as much as before. Result the same as in the other experiment.

I might note that the quantity of oil employed in all these experiments was only a fraction of "a layer" as called for in Froment patents, and, further, that no limestone was added in these experiments, because Dr. Byrnes used none and, consequently, there was practically no carbonic acid gas produced, as the small amount of rhodochrosite in the ore would not be acted upon by the very dilute sulphuric acid present and could not furnish any material quantity of carbonic acid gas.

I then repeated these experiments employing the same ore which I previously de-slimed by means of water, washing out the slime by

successive stirring with water. I took 100 grams of the ore for this purpose; after washing out the slime, I dried the residuum of de-slimed ore and it weighed 64 grams, thus representing 64% of the original ore.

Experiment 8. De-slimed ore, a repetition of my Experiment 3. A small quantity of mineral came to the surface around the edge, not enough to form a layer, and this dropped quickly to the bottom; shook for only one second.

895 Experiment 9. This is a repetition of my Experiment 4 with the de-slimed ore; shook one second; some floating material, heavy, and tended to drop back. Shook another second; a little larger amount of float. Experiment not a success, as there was no substantial separation of mineral from gangue.

Experiment 10. Was a repetition of my Experiment 5 with the de-slimed ore. The result was the same as in Experiment 9.

Experiment 11. This is a repetition of my Experiment 6, with the de-slimed ore; shook one second; layer of bubbles; practically no mineral; bubbles quickly burst; most of the mineral dropped.

Experiment 12. A repetition of my Experiment 7, on de-slimed ore, using 0.2 cc. of Hegeman's comparatively pure oleic acid; shook one second; very little float; particles sink and rise.

Not one of these experiments from 3 to 12 was a success.

A. I then repeated the same experiments, using Defendant's Feed to Flotation Plant, used by Dr. Byrnes, which had been exposed to air and dampness since the taking of Dr. Byrnes' testimony, and had suffered oxidation to a greater or less extent.

Experiment 13 was a repetition of Experiment 8. The result was very little float, which settled at once to the bottom.

896 Experiment 14 was a repetition of Experiment 9. There was quite a layer. The particles, however, were heavy and tended to go down; not a good separation.

Experiment 15 was a repetition of Experiment 10. The results were substantially identical with those of Experiment 14; not a good separation.

Experiment 16 was a repetition of Experiment 11. There was very little float, which settled at once to the bottom; not a good separation.

Experiment 17 was a repetition of Experiment 12. There was quite a layer; the particles were heavy and tended to go down; not a good separation.

3. Froment Description and Drawings of 1903.—Here we have for the first time a description by Froment of a process and apparatus capable of dealing with ore in practical quantities. He first directs crushing the ore so as to arrive at a distintegration of the particles without rendering it impalpable. The sieves are not described according to any standard known to me, or which I could ascertain. A wet process is recommended, as is undoubtedly best in practical operations at a mine or mill, and de-sliming is directed. He truthfully says that the fine slime eliminated by de-sliming could not be treated by any hitherto known method.

The de-slimed ore is fed into the mixing apparatus, which
897 he calls a centrifugal mixing apparatus containing two stirring devices worked in opposite directions and making about 300 revolutions per minute.

Then the mixer is charged with ore and water, about 1% of carbonate of lime, maximum 2% in difficult cases, and about 1 to 1½ per cent. of mineral engine oil are added. The mixing apparatus is then allowed to work for ten minutes, the chief point being that all the sulphide grains shall come into thorough contact with the oil.

This is a clear statement of the necessity of thoroughly mixing the oil and the ore.

I have repeated this operation in "Complainants' Exhibit, Reproduction of Froment Mixer," with a richer ore, and therefore with more limestone and oil, and have mixed the ore, limestone and oil, and did not obtain a particle of mineral froth or any appreciable mineral float, and have also repeated it in a cone mixer, and have even repeated it in the slide machine. The result was always the same. The substances were mixed together and the oiled ore went to the bottom. This operation is, therefore, purely a mixing operation.

The process as thus described is for a lean ore. If the ore contained more than 5% of metallic matter, Froment says it would be necessary to use more oil, and recommends 2% for ore containing up to 15% of metal, indicating this as the upper limit for copper ores in the Latin countries, while for lead ores, which are richer, Froment recommends 2½% of oil for an ore containing 30% of metal,
898 3% of oil for 40% of metal, and 3½% of oil for 50% of metal. He says it seems reasonable to assume that the proportion of carbonate of lime will follow practically the same rule. This is, however, evidently a mere assumption. After the ore, oil and limestone have been mixed, the mixture is discharged into Froment's second apparatus, described as a vat with a coil, having a rake-like stirring device, to be operated at 10 to 12 revolutions per minute. Here sulphuric acid is added through a perforated coiled pipe at the bottom, and produces the chemical reaction which is the characteristic feature of the Froment invention. The greased sulphides are said to rise to the surface carried by gas bubbles. The rake, although moving slowly, disturbs this surface and it would be reasonable to expect that much of the mineral would sink again and that the gas bubbles would escape, leaving some mineral floating by surface tension. As a matter of fact, I tried this apparatus, "Complainants' Exhibit, Reproduction of Froment Vat with Coil" and it proved to be a very poor stirring device, merely forming grooves in the oiled ore at the bottom of the vessel, and I got hardly any float.

Froment says that the stirring rake is to prevent the ore from collecting at the bottom of the vessel in too compact a mass. If the stirrer were more efficient, it would do this. He admits that a small proportion of the greased sulphide which had been carried to the surface by the gas bubbles would fall back and get mixed with the gangue, and he provides for screening the residues from the
899 bottom of this vessel. This part of the apparatus does not appear to be of any importance and I shall not describe it.

The closing statement is that the concentrated ore may be treated in a hydraulic press or filter press to recover a very large proportion of the oil.

The test of "Complainants' Exhibit, Reproduction of Froment Mixer" and "Complainants' Exhibit, Reproduction of Froment Vat with Coil" in accordance with Froment's instructions, was made in the presence of Dr. Adolf Liebmann and myself, as well as two following tests, one with the cone mixer as the mixing apparatus and an efficient hand stirring in a shallow vessel, and the other with a modern slide machine as a mixing apparatus and the same efficient stirring. These tests are fully described by Dr. Liebmann on pages 520-523 of Complainants' Record, and I will not, therefore, repeat this description. The hand stirring was with a glass rod and was carefully done so as to but slightly disturb the surface of the liquid, and the oily mineral float obtained was, therefore, not broken up as it would have been by the revolving rake in the Froment vat with the coil. Therefore, the float obtained by the hand stirring retained its gas bubbles to a considerable extent and was a somewhat pasty mass of oil and mineral with gas bubbles in it. I should say that with the Froment apparatus we obtained a very small amount of surface tension flotation, while in the other two experiments the floating mass was very much like the magma of the Froment test tube test.

900 The Froment description and drawings describe a process and apparatus and show an apparatus which discloses a development of the undeveloped ideas of the Froment patents. They provide for effective oiling of the ore with a quantity of oil much smaller than is necessary in the agitation for one second exactly directed in the Italian patent, and substantially directed in the British patent, but the Froment patents and Froment's later disclosures in his directions and drawings fail utterly from the standpoint of practicability. The minerals consumed, oil, limestone and sulphuric acid, the latter two in such quantities as to generate the gas necessary for the flotation of the ore, cause a total cost which is prohibitive, even if the process could have been compelled to work successfully in practice. The cost of the oil alone is prohibitive. For Broken Hill ores, the oil consumption would be 2½% or 50 lbs. to the short ton.

I cannot seriously consider these Froment disclosures as a disclosure of the process of the patent in suit. The process or processes are so substantially different in all essential particulars that they are not comparable.

4. Cattermole, Sulman & Picard, No. 788,247, Patented April 25, 1905, Application Filed March 29, 1904. This is the second of the Soap patents, and is known as the Soap and Flotation patent. It is a companion patent to No. 777,274, the Soap and Granulation patent.

901 It discloses the use of the soap reaction in the separation of minerals in connection with practically all processes then known in which it appears to be utilizable, except in the Granulation process covered in the companion patent patent No. 777,274.

It describes the removal of the coated mineral particles from the gangue by generating gaseous bubbles in the mixture, or by the use of buoyant material, such as greased wood and sawdust.

It is a broad patent for the soap reaction in the concentration of ores, and also specifically for the use of this soap reaction in the flotation processes as then known employing a smaller amount of oil than was necessary to float the mineral by buoyancy. It does not disclose the process of the patent in suit or anything like it.

5. Sulman & Picard Patent No. 793,808, Patented July 4, 1905, Application Filed October 5, 1903. This is known as the Bubbles patent, although the name is not descriptive, since the patent describes processes in which bubbles are not utilized, as well as those attempting to use gas or air bubbles.

In the apparatus shown in Figure 1, the effort is made to utilize air bubbles to float oiled minerals to the surface in a body of liquid which is maintained in a turbulent condition by a coiled pipe rotating at the bottom of the vessel and discharging a jet of oil and water into the liquid.

902 In the apparatus shown in Figure 2, oiled mineral is blown upon the quiet surface of the liquid in a series of spitzkasten. In the apparatus shown in Figure 3, the oiled mineral is fed down upon a rotating disc or table and is thrown outward by centrifugal force over the quiet surface of the liquid in a series of ring-shaped spitzkasten. Here no air is employed at all.

The result of all these processes is skin flotation or flotation of an oiled mineral by surface tension. That this is so as to the apparatus shown in Figures 2 and 3 is so apparent that no demonstration is necessary. As to the apparatus shown in Figure 1, I have tested it and have found that it is a poor device for oiling a mineral, but that it will to some extent float an oiled mineral by surface tension.

I used in my tests the apparatus put in evidence by the defendant as "Defendant's Exhibit, Apparatus of Patent 793,808." I only added to it for my first test the inclined baffle shown near the left hand end of the apparatus in Figure 1, which performs the function of causing all of the material to be submerged so that it will have a chance to become oiled. Without this the slime, mineral and gangue, would float off unoiled. I tried it at first with the oil-injecting apparatus supplied as part of the exhibit by defendant. This oil feed device, however, was so constructed that, when the air pressure was applied, the air bubbled up through the oil cup and prevented the oil from feeding down into the air pipe. I cannot understand

903 how defendant's expert, Dr. Byrnes, used this device for injecting oil with the air. The moment the air pressure is turned on, the oil feed stops, and if the air is turned on first and then the exit of the oil cup is opened, the air pressure prevents all flow of oil. I, therefore, replaced this oil feed device, which would not feed oil, by an oil feeding device which I now produce, so constructed that the air pressure flowed freely into the oil cup above the oil. With this device and a thin and quite pure oleic acid obtained from Hegeman's Drug Store, I was able to feed the oil very effectively and

thus carry out the inventors' idea of spraying the oil into the air on its way to the coil.

The following are the details of the experiment, with the coil apparatus of this patent. The ore used was defendant's ore crushed to 80 mesh, and 3,000 grams of ore were used, fed in at the rate of 500 grams per minute. The worm was rotated at a speed of 500 revolutions per minute. The air pressure applied was 5 lbs. to the square inch, running from a tank in which it was stored and controlled by a reducing valve. The total oil consumption was 30.5 grams. We put in 15 cc. of 50% sulphuric acid at the commencement of the operation, and no further acid was added. The result was a few oily drops floated on the surface, one-sixteenth of an inch in diameter or less; no mineral on surface except a small surface tension float. Upon examining the pulp at the bottom of the trough, it was found to be not materially oiled. On standing, a little more oil came to the surface.

904 I could not verify Dr. Byrnes' statement as to this apparatus in any particular. He says, on page 141 of Defendant's Record, that the apparatus is well adapted to oil the mineral and float it as a froth. I found that it was very poorly adapted to oil the mineral and that it did not produce any froth at all. He says that the coiled perforated pipe acts as an efficient agitator to intermingle a considerable amount of air in the pulp. I found that it simply blew air through the pulp. He says, on page 165 of Defendant's Record, that he obtained a thick and satisfactory froth, of which he skimmed off many handfuls. I did not obtain any froth at all.

The disclosure of the Bubbles patent well indicates the groping of Messrs. Sulman and Picard for a practical process of ore separation by flotation. If they had stopped with the ideas disclosed in this patent, they would not have advanced the art in any respect toward the goal which they ultimately attained, with the co-operation of Mr. Ballot.

The process of the patent in suit is not disclosed in this patent and Messrs. Sulman and Picard might well have been discouraged by the inefficiency and practical uselessness of all that is disclosed in this patent from any further effort to concentrate an ore by flotation assisted by air or gas.

Adjourned to Thursday, December 12, 1912, at 10:30 in the forenoon, at the same place.

905 New York, December 12, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

Direct examination continued:

(Answer to 124 Q. continued:)
6 and 7. Kirby Patents, No. 809,959 of January 16, 1906, Application filed December 14, 1903, and No. 838,626, Patented De-

cember 18, 1906, Application filed December 17, 1903. The first of these two documents discloses a process of separating minerals. The second discloses a separating tank used in this process. In the process, a thin oil is used in the proportion of from 25 to 75 per cent. of the ore, which is from 500 to 1,500 lbs. to the short ton of ore. The oil is kerosene, having dissolved in it 5% of Trinidad asphalt.

The process is a buoyancy process, like Elmore, but the patentee hopes to assist the buoyancy of some of the particles by air. The patentee says (p. 2, lines 56-66):

"Some of the hydrocarbon-coated particles will float to the surface without assistance; but a considerable quantity of such particles will not be sufficiently buoyant, and some of such particles and some globules of the mixture would be trapped in the sands. In order to recover this less buoyant material together with the globules of the mixture, the mass which tends to settle is slowly lifted and
906 turned over to liberate the coated particles and the globules, and at the same time a gas, preferably air, is blown into the mass, preferably near the bottom thereof."

That a floating layer of oil carrying mineral is obtained is quite clear. The patentee says (p. 3, lines 55-57):

"The floating concentrates are carried mainly at the lower surface of the hydrocarbon layer, where it is in contact with the water."

Kirby mixes in one vessel, the mixer A, and then flows the mixture into another vessel, the separating tank B, in which this slow stirring and blowing in of air takes place and the floating layer of oil carrying mineral is formed. A skimming bar 28 carries the float into a settling and washing chamber or box 29 (Fig. 2) at the top of the separating tank, from which the flood flows into a filter which recovers part of the oil. The remainder of the oil recoverable is distilled from the concentrate in a retort.

This process is so plainly an oil buoyancy process that it seems surprising that Dr. Byrnes should mislead himself into the belief that it is a frothing process.

There is absolutely no foundation for this belief. Dr. Byrnes says (Deft.'s Rec., p. 151) that the mineral "floats as a froth" in a separating tank, and that the "froth of concentrates" is directed by the curved skimming bar into the settling and washing
907 chamber. This directly contradicts the statement of the patentee above quoted that he has here a "hydrocarbon layer" (oil layer) in which "the floating concentrates are carried mainly at the lower surface * * * where it (the oil layer) is in contact with the water."

As for Dr. Byrnes' alleged Kirby tests described on pages 161, 162, of Def. Rec., it is as different from Kirby as is Dr. Byrnes' description.

The Kirby process is not the process of the patent in suit. It is an attempt to use the Elmore buoyancy process with thin oil and some economy in oil. I have tested it on a small scale and found that the thin oil did not very effectively hold up the metal in the floating oil layer, and that the streams of air only disturbed and

sank the metal carried in the floating oil layer. The Kirby process is very far removed from the process of the patent in suit.

General Remarks on Processes of Ore Treatment with Oil. There are, in the six sub-divisions of this class of process, twenty-three documents. As the Froment Italian and British patents are identical in substance, we have twenty-two inventions each aiming to solve the problem of the economical and effective concentration of ores by the utilization of the preference of oil for the mineral. These inventions commence with Haynes in 1860. Then there is a gap of more than twenty-five years. Then comes Everson in 1886,
the efforts to utilize it in modified forms in 1889 and 1890,
908 Robson in 1897, the Elmores in 1901, Froment in 1902, the Cattermole series commencing in 1903 (application for patent No. 777,273), the graphite group, Glogner, Good and Kendall, in 1903 and 1904, the Kirby applications in 1903, the first Schwarz application in 1904, the Sulman and Picard first efforts in 1904. The Wolf process in 1904 I have considered under the heading "Apparatus." That may also be added to the list. This record of invention is a record of partial or complete failures. It is in evidence that Elmore was used to some extent and that Cattermole was used to a small extent, but both of these processes long ago disappeared from use. The amount of capital invested and lost in these unsuccessful inventions would, no doubt, make a stupendous figure. The human effort must have been very great.

But the process of the patent in suit solves the problem. It is simple, it is economical, and it is efficient. It can be used in simple apparatus. The expense of operation is slight and the recoveries are large, yet none of these prior documents discloses it. The phenomenon of the agitation mineral froth was an unknown phenomenon until discovered by Messrs. Sulman, Picard and Ballot, and made known by them in the patent in suit, and in twenty-four corresponding patents taken out in Europe, Asia, Africa, Australia and the Americas.

125 Q. Having now considered the prior art, both as set forth by
the defendant and as supplemented in complainants' re-
909 buttal testimony, what have you to say as to the novelty of the invention disclosed in the patent in suit?

A. The process of the patent in suit is a new process, not disclosed in any or all of the documents referred to by complainants or defendant as prior documents. It was to me a most surprising process. After studying all these prior documents, my surprise is not diminished that such a process is possible. There is nothing like it disclosed in the prior art and the failures of other inventors tended to discourage rather than to encourage the hope that the economical concentration of ores was capable of realization in a process utilizing the affinity of oil for metallic substances.

Of all the prior processes, the nearest approach to the process of the patent in suit was the Cattermole granulation process. Here there was agitation of an ore pulp with an amount of oil as small as 1½% of the ore, or 30 lbs. to the short ton, and with reasonably small quantities of acid, utilized only for its physical action in in-

creasing the preference of the oil for the mineral. This was a simple and workable process, but it was the reverse of the flotation process. The agitation and oiling of the mineral caused the mineral particles to stick together and form granules having greater weight in proportion to their surfaces than the original particles, so that they not only went to the bottom, but they resisted an up-current of water strong enough to carry away the gangue. This taught
910 that the best way to concentrate an ore was to sink the metallic particles.

Then we have the Froment principle of generating carbonic acid by the use of sulphuric acid and limestone and attempting to float the mineral by the generated gas. Nothing of practical value came from this principle, and there was the Sulman and Picard idea of lifting the mineral to the surface by streams of air, and nothing of practical value came from this. Then we have the oil buoyancy processes of the Schwarz and Kirby—efforts to assist buoyant action of the oil by blowing in air—and, finally, we have the Elmore oil buoyancy flotation process, in which the mineral was made so light by entrapping it in great quantities of oil that the mixture of oil and mineral became lighter than water and floated. This briefly summarizes the prior art.

The simplicity of the process of the patent in suit is as remarkable as its economy. For continuous operation only two pieces of apparatus are required, an agitator for briskly agitating the ore pulp and beating air into it, and a spitzkasten or separator in which the froth may rise to the surface and float off into a launder. The oil consumption is one one-thousandth part of the weight of the ore treated, equal to 0.1%, equal to 2 lbs. to the short ton of ore. The acid consumption, since no chemical action is required or desired, is extremely small. Some heating is usually required, but this is not carried to such a point as to be a serious item of expense.
911 The remarkable thing about the froth produced in this process is its permanency. The bubbles of air, with water films, are thickly coated with mineral particles and appear to be armored by these metallic particles. The froth piles up thickly and carries the great weight of the mineral particles, which are the heaviest particles of the ore. The oil has entirely disappeared from sight and sense. It cannot be seen and it cannot be felt, and the particles of mineral are just as bright as though there was no oil upon them at all.

I regard the process of the patent in suit as one of the most remarkable and surprising processes which has ever been brought to my attention, and the invention is one of the most important inventions in the metallurgical art, and I further regard it as an entirely novel process not disclosed in the prior art.

126 Q. In considering the Froment Italian patent, you said that the thinnest possible layer of thick residuum oil required a quantity of oil 11.7% of the ore. What particular oil did you use in this test, and what capacity of test tube?

A. It was what is known as Winter dark oil; sample just received from London. I believe it is about the thinnest residuum oil that

is known in the art of ore treatment. The Summer dark oil is darker and a thicker oil than the Winter dark oil, and I tested this and found that it required 1.4 grams of oil to make a layer of water in an 80 cc. test tube, equal to 14.4% of oil on the ore.

912 127 Q. Dr. Liebmann, in answer to 41 Q. (Complts.' Rec., page 524) says that you were present on November 5, 1912, when he repeated his test tube reproduction of Dr. Byrnes' alleged Froment slide machine tests. What have you to say to this?

A. This statement is true. I made careful notes of all these tests and can repeat them if desired. The tests which I have particularly described in my testimony were made later.

128 Q. It is suggested in the deposition of the defendant that the word "powdered," as used in the patent in suit, means dry, as applied to powdered ore. What have you to say as to this suggestion?

A. It is not limited to dry pulverization. When a substance is not soluble in water, it is quite common to grind it under water to an impalpable powder or pulp, which may or may not be afterwards dried. This is a very common custom with minerals, and has long been employed both for ores and for quartz, feldspar, etc., as used in the porcelain industry.

129 Q. What are the physical qualities of sulphuretted hydrogen, or hydrogen sulphide, and is it or is it not poisonous?

A. Sulphuretted hydrogen is a gas having a very characteristic and disagreeable odor. It is very offensive and poisonous, and I have heard of workmen being killed by it in factories where it was liberated; in fact, one of my assistants working in my laboratory was rendered insensible by it. Fortunately I was present,

913 and with the assistance of two of my students I carried him at once into the open air and he recovered. As sulphuretted hydrogen is a very valuable reagent in chemical analysis, it is often employed in laboratories and its odor can often be perceived, but it is customary to have specially constructed hoods, well ventilated, in which the apparatus is placed while the gas is being utilized.

130 Q. Have you made a test of "Defendant's Exhibit, Apparatus of Patent in Suit," without using baffles in the cone mixer? If so, please describe it.

A. I have. The boxes or spitzkasten were filled with circuit water at a temperature of 50° Centigrade. The ore employed was defendant's crushed to pass through an 80 mesh sieve. 500 grams of ore and 3,200 cc. of water, and 3 cc. of oil of vitriol were put into the agitator. This quantity of acid was employed on account of the large amount of water in the agitator and the spitzkasten. The oil employed was defendant's red oil. The quantity employed was 0.75 cc., which is equivalent to 0.675 gram, which would be 2.70 lbs. per ton of ore, equal to 0.13% on the ore. The ore, etc., was agitated for about two minutes by hand, with frequent reversals of direction. There were no baffles in the agitator. There appeared half an inch of froth in the agitator, and when the contents of the agitator were discharged, the froth ran out on the launder and floated on the spitzkasten. Considerable froth was left in the agitator. I should

add that, before this experiment was made, a gate-valve was
914 substituted for the globe valve which was on the original exhibit. This facilitated the discharge of the froth. The apparatus of the patent was intended for continuous use, and such a test as this is not a fair test of the apparatus, and, as it was worked by hand, it did not give sufficient agitation. But, nevertheless, there was a considerable amount of froth in evidence.

Direct examination closed.

Cross-examination.

By Mr. Scott:

131 X Q. Will you state what wood tar is and how it is prepared?

A. A wood tar is a product of the destructive distillation of wood. When wood is placed in a closed vessel and subjected to heat, the first product is water. When the temperature reaches something like 500° Fahrenheit, the woody tissue begins to undergo decomposition, and it gives off a variety of products which vary according to the particular kind of wood under treatment. If the wood is that of a deciduous tree, such as beechwood, acetic acid and methyl alcohol are among the first products next to water, the mixture being known in commerce as pyroligneous acid. If the heat is continued, tarry products come over, which condense into wood tar, and charcoal is finally left behind as the last product.

915 If, on the other hand, the wood is a resinous wood, like pine or spruce, the first product will be water, then will come oil of turpentine, and then will come a series of oils containing quite a variety of chemical products, alcohols and ketones, which are known in commerce as pine oils, and, finally, pine tar, leaving charcoal behind.

If the tars thus produced are subsequently redistilled, oily products are obtained known as tar oils.

In the case of the deciduous trees, creosote is one of the oily products of the distillation. This is a mixture of phenol, cresol and the corresponding ethers.

I could go further, but probably I have given you all the information you want. I might add that tar, in general, no matter from what material it is produced, is a most complicated mixture of products.

132 X Q. Upon your direct examination you referred to "wood tar, coal tar and all their derivatives, such for example as pine oil, sweet pine oil and wood tar oil." I take it from your last preceding answer that you did not intend, in the passage quoted, to convey the idea that pine oil and sweet pine oil are derived from wood tar. Am I correct?

A. The pine oil and the sweet pine oil would be in the tar if the distiller did not collect them separately. They belong primarily to the tar, which results from the destructive distillation of the wood, but in recent years, since a market has been found for pine oil, the distiller collects separately the first portion of the distillate and this

constitutes pine oil. He has often recently extracted pine oil
916 by distilling the wood in a bath of melted resin, and thus obtained it in a purer condition than he could do if he first produced wood tar and then separated the pine oil from it. I think it is proper to call pine oil a derivative of wood tar, just as we call phenol and cresol derivatives of coal tar.

133 X Q. In the manufacture of pine oil and sweet pine oil, does the distiller first remove from the wood by distillation the various products you have mentioned, including pine oil and sweet pine oil, leaving the remainder as tar; or does the distiller first remove certain of the products, leaving a mass which he calls tar containing sweet pine oil and pine oil, and subsequently treat this residue or tar for the purpose of extracting the pine oil and sweet pine oil therefrom?

A. This business is carried on in three different ways. First, the old fashioned way, in which pyroligneous acid and tar are the only products, the pyroligneous acid containing the methyl alcohol, and the tar containing everything else. Subsequently the tar was exposed to fractional distillation and oils were obtained from it.

Second, pine wood is sometimes distilled by immersing it in small pieces in a bath of melted resin. In this way, a distillate is obtained which contains the lighter oils, which were formerly included in the tar by themselves.

Third, another plan which is practised by some of the distillers is to immerse the wood in a bath of very heavy petroleum oil
917 and heat it at carefully regulated temperatures, so as to secure the lighter products containing the oils separately from the tar, which either comes over later or which they may not take the trouble to produce at all.

134 X Q. You have said that the process of Cattermole Patent No. 777,273 is not adapted for use with lean ores. Is there any reason why the process of the Cattermole, Sulman and Picard patent, No. 788,247, is not applicable to lean ores as well as to rich ores, that is, to ores containing a small amount of metalliferous mineral, as well as to those containing a large amount?

A. I don't know.

135 X Q. You do not find anything, do you, in the specification of patent No. 788,247 to indicate that the patentees thought their process inapplicable to lean or poor ores?

A. I find nothing in the specification which states in so many words whether the process is suitable for lean ores or not. The author mentions two or three ways of getting the particles of valuable mineral, after they are coated with fatty acids, to the surface, but he does not intimate whether one method is adapted for rich ores and another method for poor ores. I notice one of his methods introduces wood, sawdust or other suitable material which are to be made to adhere to the mineral particles to cause them to float, but he does not state whether this particular treatment is or is not adapted to poor ores.

918 136 X Q. Referring to patent No. 788,247, what is your interpretation of the function performed by the oil which is

used, that is, the oil which results from the decomposition of the soap?

A. I understand that it coats the particles of minerals with an oily film, which repels water, while the particles of gangue, being wetted with water, do not receive a coating of oily matter from the soap. The consequence is, if these particles of oiled mineral get to the surface, they float there by surface tension.

137 X Q. You stated in the first deposition which you gave in this suit, that, in the processes of Cattermole patents, 777,273 and 777,274, "so large an amount of oily matter is employed as to agglomerate together the metalliferous particles contained in the ore into granules or pellets." Is it your understanding that the amount of oil used in Cattermole, Sulman and Picard patent No. 788,247 is also of such a quantity as to cause the metalliferous particles to agglomerate together?

A. There is no statement in the specification of the quantity of soap added or the quantity of fatty acid to liberate it nor is there any suggestion of agitation by which oiled particles of ore might be agglomerated into granules. After the oiling of the particles has been accomplished, the patentees merely suggest that these oiled particles may be brought to the surface by gas bubbles or brought to the surface by added particles of wood or sawdust previously coated with fatty acids by means of the soap treatment.

919 138 X Q. Do you find the specification of Cattermole, Sulman and Picard patent No. 788,247, to contain sufficiently explicit directions to enable one to apply the process there set forth and particularly that species of the process which includes, after oiling, flotation by gas bubbles?

A. The specification is certainly not very explicit. In the first place, it mentions a variety of substances to be added to the water, as soaps or similar compounds, such as cresols, phenols, resinous bodies, etc., and gives no idea of the preferable material and no idea of the proper quantities to be employed. There is a wide difference in the different materials which are mentioned as equivalent to each other; for example, an oleic acid soap and a phenol compound. Phenol when set free from its alkaline compound by an acid is quite soluble in water, while the true fatty acids set free from soap are practically insoluble in water, or nearly so. It would seem to me that very different quantities of these different substances would have to be selected according to their respective properties. It seems to me that it would be necessary to conduct a number of experiments to successfully practice the process, even if that be possible, and I have my doubts whether the process is practicable at all.

139 X Q. If the process of the Cattermole, Sulman and Picard patent No. 788,247 were to be carried out with an ordinary soap, what would be your understanding as to the amount of oleic acid, to be liberated from this soap by the mineral acid, that is,

920 what quantity of the oleic acid eventually obtained in a free state would be necessary—a quantity great enough to cause the metalliferous mineral particles to agglomerate together, this

being the quantity you referred to in connection with Cattermole patents 777,273 and 777,274, or a greater or less quantity?

A. My only basis of calculation is the statement of Cattermole himself in patent No. 777,273, where he uses soap and oil. He says:

"usually an amount of oil varying from 4 per cent. to 6 per cent. of the weight of metalliferous mineral matter present in the ore yields granules of suitable size, consistency and specific gravity for ready separation from the gangue."

Below that quotation he says:

"When soap is employed, an amount varying from 3 per cent. to 5 per cent. of the weight of oil usually suffices."

Now I have not the slightest idea whether Cattermole used substantially the same proportions of fatty matter in the form of soap in patent 788,247 as he used in patent 777,273. He doesn't say in the later patent that he has to use any more than he did in the prior patent. As a matter of fact, 788,247 was applied for March 29, 1904, while patent 777,273 was applied for September 28, 1903, but the later patent does not state whether more or less fatty
921 matter is required than in the earlier one.

Adjourned to Friday, December 13, 1912, at 10:30 in the forenoon, at the same place.

New York, December 13, 1912.

Met pursuant to adjournment.

Present: Counsel as before.

Cross-examination continued:

(Answer to 139 X Q. continued:) It thus appears that the only one of the three patents referred to which specifies the amount of oil is patent No. 777,273, and the amount of oil specified is from 4 to 6 per cent. of the metalliferous mineral. In this patent the soap is used as an emulsifying agent and not as a substitute for oil, so the amount of soap to be used in connection with the oil has no relation to the amount of soap to be used when the soap is employed as a source of oleic acid and as a substitute for oil.

140 X Q. Referring to Dr. Byrnes' experiment with the Kirby process as described by him at page 161 of Defendant's Record, will you state how much blende could theoretically be floated in water by the 125 grams of kerosene used by Dr. Byrnes, without the assistance of any buoyancy derived from air, but relying exclusively upon the buoyancy imparted by the kerosene by virtue of its specific gravity?

922 A. I have reduced this problem to a formula, as follows: Let X equal the volume of oil to be added to 1 volume of

blende to reduce the specific gravity of the mixture to unity, that is, to the specific gravity of water.

The formula is as follows:

$$X = \frac{\text{Specific Gravity of Blende} - 1}{1 - \text{Specific Gravity of Oil.}}$$

This formula as applied to blende and kerosene oil is as follows:

$$X = \frac{4 - 1}{1 - 0.7935} = \frac{3}{0.2065}$$

The result of this equation is:

$X = 14.65$ volumes of oil.

Dr. Byrnes used 125 grams of kerosene. This would be sufficient to float 43.2 grams of sulphide of zinc or blende. The 500 grams of ore contain 30% of blende, which would be 150 grams of this mineral. If the 125 grams of oil floated 43.2 grams of blende, then there were 106.8 grams of blende not floated by oil, theoretically, of course. If Dr. Byrnes had used Kirby's maximum of oil, 375 grams or 75% of the ore, he could theoretically have floated 129.6 grams of blende, still leaving 20.4 grams not provided for.

923 This calculation simply shows the amount of oil necessary to bring the mixture of oil and blende to the specific gravity of water. To secure flotation, it would, of course, be necessary to have a slight excess of the oil so as to reduce the specific gravity of the mixture below that of water.

141 X Q. Will you please state the specific gravity of the following oils: Crude petroleum, kerosene, lubricating oil, residuum, pine oil, sweet pine oil or pinoline, wood tar oil, cottonseed oil, eucalyptus, olive oil, turpentine, and oleic acid?

A.

Crude petroleum	0.8156	to 0.7978
Kerosene	0.807	" 0.7935
Lubricating oil	0.885	
Residuum	0.900	
Pine oil	0.9571	to 0.8696
Sweet pine oil or pinoline	0.940	
Oil of wood tar	1.030	
Cottonseed oil	0.920	to 0.926
Eucalyptus oil	0.850	" 0.925
Olive oil	0.914	" 0.919
Turpentine	0.865	" 0.875
Oleic acid	0.900	

These figures are not exact, because there are slight variations in the processes of different manufacturers.

142 X Q. If we have a known or assumed weight of a mixture of oil and zinc sulphide and desire to ascertain the proportions of zinc sulphide and oil, would not the solution of the following
924 equations be a correct method for determining the weight of oil and weight of zinc sulphide in the mixture:

w = Weight of Mixture.
r = Specific Gravity of Mixture.
x = Weight of Oil.
m = Specific Gravity of Oil.
y = Weight of Zinc Sulphide.
n = Specific Gravity of Zinc Sulphide.

$$w = x + y$$

$$\frac{w}{r} = \frac{x}{m} + \frac{y}{n}$$

A. In my opinion it is.

143 X Q. Now the specific gravity of zinc sulphide being 4, what would be the weights of zinc sulphide and an oil of a specific gravity of 0.8 in one gram of a mixture having a specific gravity of 1?

A. One of zinc blende to three of oil.

144 X Q. Will you answer the same question in refcrence to an oil having a specific gravity of 0.9?

A. It would be one of zinc sulphide to 6.7 of oil.

145 X Q. And will you answer the same question having reference to an oil of a specific gravity of 0.95?

A. It would be one of zinc blende to 15.7 of oil.

Cross-examination closed.

By Mr. Williams: The offer made during the deposition of
925 Dr. Liebmann to repeat any of the tests or experiments testified to by the witness is here repeated as to the experiments referred to by Dr. Chandler in his deposition.

Redirect examination.

By Mr. Williams:

146 R. D. Q. Does or does not the statement in the claim of the Froment Italian patent, that the oil must have an "oily fat body," exclude pine oil and sweet pine oil from the oil or oils thus described.

A. It does exclude them.

Redirect examination closed.

Deposition closed.

CHARLES F. CHANDLER.

Mr. A. Howard Higgins, recalled, testified as follows:

Direct examination.

By Mr. Williams:

23 Q. You have heretofore testified as to the production by you of an agitation mineral froth in March, 1905, in a cone mixer. Can you produce the original apparatus which you then used?

A. No. The original apparatus has been worn out and scrapped.

24 Q. Please produce a substantial reproduction of that apparatus, containing baffles such as were in that apparatus.

926 A. I now do so.

By Mr. Williams: The apparatus produced by the witness is offered in evidence and marked "Complainants' Exhibit, Cone Mixer."

The apparatus which was produced by Dr. Chandler as the modified oil feeding apparatus used by him in the test made by him of "Defendant's Exhibit, Apparatus of Patent No. 793,808," is also offered in evidence and marked "Complainants' Exhibit, Modified Oiling Apparatus."

25 Q. Is it possible for you to produce the series of cone mixers, and the series of spitzkasten such as are shown in the drawings of the patent in suit, which were the original apparatus used in the laboratory of Minerals Separation, Limited, in the year 1905?

A. No. This apparatus has also gone into the scrap heap.

26 Q. Dr. Liebmann describes certain experiments made by him in "Defendant's Exhibit, Apparatus of Patent No. 793,808," and in his experiments 1 and 2, described on page 418 of Complainants' Record, he says that the oil was sprayed in by air. Were you present when these experiments were conducted, and, if so, will you please state what apparatus was used for obtaining the oil feed which he described?

A. I was present, and saw "Complainants' Exhibit, Modified Oiling Apparatus," being used.

27 Q. Dr. Liebmann, on page 387 of Complainants' Rec-
927 ord, describes an experiment carrying out the Everson invention and says that the mixture was run into a washing-out vessel and the concentrate removed by a constant overflow of water, but does not say whether or not the water in the washing-out vessel was acidulated. Were you present, and was the water acidulated?

A. I was present and saw the water acidulated before use.

28 Q. Dr. Chandler has described in his testimony an experiment carrying out the instructions of the Everson patent as to the second method of treatment described therein. Have you had an assay made of the concentrates and tailings which were obtained as a result of that experiment, and if so, will you kindly give the figures as to zinc?

A. Yes, I had assays made by Constant & Company, the results being as follows:

Original ore	Zinc	21.8%	Insolubles	58.2%
Concentrates	"	15.8%	"	67.6%
Tailings	"	22.0%	"	57.6%

It is stipulated that this assay will be accepted as evidence without the production of the assayer.

29 Q. I have had a drawing made on a smaller scale following the large blue print "Complainants' Exhibit, Drawing Australian Model Plant." Please state whether or not this smaller scale drawing, which I now produce, represents this plant as used in Minerals Separation laboratory.

928 A. Yes.

30 Q. I noted in the original drawing that four holes were shown in each of the walls between the agitation boxes and according to your instructions I had three of these closed by plugs, leaving a single opening for the liquid to flow from agitation box to agitation box. Was this a proper representation of the thing as used, and what was the purpose of the provision of four holes?

A. Yes. The four holes were provided for the purpose of experiment, in finding the effect of the passage of the liquid from agitation box to agitation box in using different combinations of openings.

"It is stipulated that the drawing now produced may be substituted in place of the large blue print marked "Complainants' Exhibit, Drawing Australian Model Plant," as an exhibit herein, the blue print, however, to be produced upon demand.

It is also stipulated that the drawing marked "Complainant's Exhibit, Froment Plan," be replaced in evidence by a reduced drawing thereof now produced and similarly marked, the original, however, to be produced at any time upon demand.

The same stipulation is made as to "Complainants' Exhibit, Froment Drawing A," and as to "Complainants' Exhibit, First Tracing of Slide Machine."

929 31 Q. Have you made tests in a modern continuously-operating plant for the production of the agitation froth, using cottonseed oil in the proportions used by Dr. Byrnes in his second test in the slide machine alleged to be in operation of the Froment British patent described by him on pages 165 and 166? If so, please give the details of this test.

A. Yes, I have made tests at Butte, Montana, in a plant substantially the same as that shown in the drawings "Complainants' Exhibit, King John's Court Standard Plant," with the exception that there were six spitzkasten instead of five. The apparatus is a small one, having a capacity of 10 lbs. of ore per minute. The ore used was from the Elm Orlu mine, which is adjacent to the Black Rock mine of the Butte & Superior Copper Company. With the exception of the presence of some clay in the ore, it was practically identical with the Black Rock ore. After being crushed to 80 mesh, it was fed to the plant at the rate of 10 lbs. per minute, sulphuric acid and cotton seed oil being fed in the proportions used by Dr. Byrnes in his

second test. In about three minutes the plant had settled into a permanent condition. The float on the first spitzkasten was copious, being about one inch to an inch and a half deep, and though oily in appearance when closely examined, did not differ in appearance from the usual agitation froth at a distance of a few feet. These floats were exceedingly dense and occasionally fell down in large masses. The tailings contained some granules and did not
930 indicate a satisfactory recovery. Samples were taken of these products and assayed:

Original ore.....	Zinc	20.41%	Insolubles	59.95%
Concentrates	"	47.54%	"	11.82%
Tailings	"	12.94%	"	72.24%

giving a recovery of 50% of the zinc in the concentrates.

The small plant that I used is nominally a five-ton plant, although its maximum capacity is seven tons per day. This plant is not intended for commercial use in treating zinc ores, being only a testing plant. The percentage of oil used in the test was 3.6 on the ore, corresponding to the 20 cc. of cottonseed oil used by Dr. Byrnes.

Direct examination closed.

No cross-examination.

Deposition closed.

A. HOWARD HIGGINS.

By Mr. Williams: The following documents, heretofore marked for identification, are offered in evidence and entitled *respectfully* "Complainants' Exhibit" and the title hereinafter given by which they were identified when marked for identification:

931 "Cable, Hoover to Hyde, January 18, 1910;"
"Cable, Hyde to Hoover, January 20, 1910;"
"Cable, Hoover to Hyde, January 21, 1910;"
"Cable, Hyde to Hoover, January 24, 1910;"
"Letter, Minerals Separation to Hyde, March 2, 1910;"
"Hyde Acceptance, March 3, 1910;"
"Cable, Minerals Separation to Hyde, Dec. 8, 1910;"
"Cable, Hyde to Minerals Separation, December 9, 1910;"
"Letter, Minerals Separation to Hyde, November 23, 1910;"
"Hyde Report, January 8, 1911;"
"Copy Memorandum re Managership of Minerals Separation American Syndicate, Limited;"
"Letter, Hyde to Minerals Separation American Syndicate, January 17, 1911;"
"Letter, Minerals Separation to Hyde, February 1, 1911:"

It is noted that, as to those of the above documents which were produced by the defendant, by stipulation, the original documents produced by him have been returned to him and replaced by copies to have the same force and effect as the originals, the originals to be produced upon demand.

It is further stipulated, as to all printed written documents produced in evidence, that the copies thereof in the printed rec-
932 ords shall take the place of the original documents, the originals to be produced upon demand.

Adjourned to Saturday, December 14, 1912, at 10:30 in the forenoon, at the same place.

New York, December 14, 1912.

Met pursuant to adjournment.
Present: Counsel as before.

GEORGE A. CHAPMAN, recalled, having been duly cautioned and sworn, deposes as follows:

Direct examination.

By Mr. Williams:

246 Q. Are you the same George A. Chapman who has heretofore testified as a witness for the complainants?

A. I am.

247 Q. I now show you two exhibits marked, respectively, "Complainants' Exhibit, Reproduction of Froment Mixer" and "Complainants' Exhibit, Reproduction of Froment Vat with Coil." Please state whether or not these exhibits are reproductions of parts of the Froment apparatus which were in the laboratory of Sulman and Picard and of Minerals Separation, Limited, during the year 1904, and which as you have heretofore testified in answer to 4 Q. you tested.

A. These exhibits are an almost exact reproduction of the old Froment apparatus which I used about 1904. The Froment
933 mixer appears to be a little bit larger in diameter, but the rotating devices inside are almost exactly the same as in the old apparatus. The only difference that I can see is that screws hold the teeth in place instead of rivets. My memory is refreshed by seeing this device and I want to correct a statement that I have made before that the agitator consisted of wire beaters. My memory was confused at that time because of the Robson & Crowder mixer which we had in the laboratory at a later time than when I used the Froment mixer and in which there were stout wires something like a grid. We also had in the laboratory a mixer like an egg beater. That was used in connection with the tests on breaking down Cattermole granules. The memory of these different apparatus confused me, but now that I have seen this Froment reproduction, I am very sure that the old Froment mixing device has been here substantially reproduced.

I may add, however, that there was a sort of hopper on the side of the old Froment Mixer, which I understand from Mr. Higgins it was not deemed necessary to reproduce.

The vat with coil agrees exactly with the description which I gave before. As I think it over carefully, it may be possible that the points of the rake were sharpened in the old Froment apparatus, but I am sure this would not make any difference.

248 Q. I call your attention to your answer to 139 X Q. in your former deposition, appearing at page 208 of Complainants' 934 Record, and ask you whether with the proportions there stated, 20 grams of ore and 70 of water, you would have added oil "by drops equivalent to 1½ to 2 lbs. of oil per ton of ore?"

A. No. With such an amount of ore, one drop of oil would be more than 1½ to 2 lbs. to the ton. The only way to get a small enough quantity of oil for such a test would be to use a soap solution, which could be made sufficiently weak to carry the fraction of a drop of oil that would be required in such a test. This would be decomposed by the sulphuric acid and the oil set free. I am quite sure that I have made tests that way, although tests of this kind are only rough tests to indicate the possibility of obtaining the agitation froth with an ore. Never at any time have I used this method for a quantitative test. The slide machine is the usual apparatus for the first quantitative test.

249 Q. Have you made tests in a modern, continuously operating plant for the production of the agitation froth, using cottonseed oil in the proportions used by Dr. Byrnes in his second test in the slide machine alleged to be an operation of the Froment British patent and described by him on pages 165 and 166 of Defendant's Record? If so, please give the details of this test or tests.

A. I made a test in the London Standard plant. This is the same plant described by Dr. Liebmann in his testimony, page 499 of Complainants' Record, containing eight agitators and six flotation 935 boxes and it was used in the same conditions as when Dr. Liebmann used it in his London experiments. This is known as a fifty ton plant and could be worked at that capacity at a mine, but it is used for testing purposes only and never run to its full capacity.

The ore that I used was Broken Hill tailings, containing about 18% of zinc and about 5% of lead. This ore was crushed to pass through an 80 mesh screen. The plant was operated for an hour and 1,680 lbs. of ore were fed in during this period. Cottonseed oil was used in the proportion of 3.6% of oil on the weight of the ore and the acid consumption was 0.37% on the weight of the ore. (1 cc. is 1.8 grams, which is 0.368% of 492 grams of ore). The temperature of the water was maintained at 70° Fahrenheit.

An oily float was obtained, some of which was carried below the surface of the water. I made adjustments so as to carry this float over; certainly more than 30% of it was carried below the surface of the water. There were large, clean, oil-film bubbles in it and it did not look at all to me like an agitation froth such as is obtained under normal and economical conditions of oil consumption. The float looked oily and it was oily to the touch, whereas the normal agitation froth does not show the presence of oil nor can you feel that there is any oil in it.

The tailings were oily and dirty and contained incipient granules. I took some of these tailings and rolled them in a Gabbett 936 without baffles and obtained good granules.

I separated the concentrates which overflowed from the six flotation boxes and had them separately assayed, and also had the tailings assayed.

The returns were as follows:

Experiment No. 1.

	Weight, total lbs.	Percentages.			% recov.	
		Insol.	Zinc.	Lead.	Zinc.	Lead.
1st Conc.	26.6	14.1	28.8	9.0	2.52	2.92
2nd Conc.	21.7	12.6	29.9	8.9	2.14	2.35
3rd Conc.	14.2	11.0	31.4	8.8	1.47	1.52
4th Conc.	25.2	11.2	30.7	8.9	2.54	2.72
5th Conc.	21.2	20.5	26.7	7.3	1.87	1.87
6th Conc.	20.6	14.2	30.9	8.5	2.1	2.12
Tailings	1,550.5	——	17.1	4.6	87.5	86.6

The recoveries of zinc and lead in the total concentrates were, zinc, 12.6%; lead, 13.6%.

The amount of sulphuric acid used by Dr. Byrnes was less than the normal amount used in the agitation froth process for Broken Hill tailings, and so I ran another test, using an acid consumption of 25 lbs. to the ton, which is rather more than the normal acid requirement of this ore when using the agitation froth process under proper conditions. Everything else, as to temperature, time, materials, etc., was exactly the same as in the test just described. The results were assayed and the assay returns were as follows:

937

Experiment 2.

	Weight, total lbs.	Percentages.			% recov.	
		Insol.	Zinc.	Lead.	Zinc.	Lead.
1st Conc.	71	6.0	37.9	9.0	9.03	8.73
2nd Conc.	51	5.8	38.2	9.0	6.58	6.27
3rd Conc.	39	7.3	36.3	8.7	4.8	4.63
4th Conc.	34	8.4	35.6	8.5	4.1	3.95
5th Conc.	27	11.2	34.6	8.1	3.12	3.00
6th Conc.	27	5.2	38.6	8.5	3.5	3.13
Tailings	1,431	——	14.2	3.6	68.6	70.25

The recoveries of zinc and lead in the total concentrates were, zinc, 31.13%, and lead, 29.71%.

The results of this second test were a little better than of the first test. They were both wasteful in the great quantities of oil used and absolute failures as to the results.

I took some of the tailings from my test No. 2 above described and made granules from them by rolling them in a cone mixer or Gabbett without baffles. I have brought a specimen of these granules with me and I now produce it.

The floating material obtained in this second test was practically the same as in the first, only it contained more mineral and less gangue.

After I had made these two tests, it was suggested to me by our patent agent, Mr. Ballantyne, that I would more nearly parallel Dr. Byrnes' tests by having less agitation. Dr. Byrnes agitated in a slide machine for thirty seconds for his first agitation and from ten to twenty seconds each for his subsequent agitation.

938 We usually agitate one and a half to two minutes for the first agitation in the slide machine, and half a minute to one minute for subsequent agitations. To repeat this condition of under agitation, I made another test with proportions of all material, temperature and time the same as in my experiment No. 1, but using only six agitators, one agitator for each of the six flotation boxes. The results were a slight improvement on the results in test No. 1. The floating material was the same and the tailings contained incipient granules which I granulated as I have described before. The results were assayed and the assay returns were as follows:

Experiment 3.

	Weight, total lbs.	Percentages.			% recov.	
		Insol.	Zinc.	Lead.	Zinc.	Lead.
1st Conc.	25.3	12.5	30.5	7.8	2.36	2.06
2nd Conc.	37.6	10.4	33.3	7.6	3.84	3.00
3rd Conc.	31.0	10.6	34.1	8.0	3.24	2.60
4th Conc.	46.3	10.8	34.1	7.9	4.84	3.82
5th Conc.	42.0	14.5	33.0	8.1	4.25	3.56
6th Conc.	23.0	11.7	33.6	7.5	2.36	1.81
Tailings	1,474.8	——	17.5	5.4	79.1	83.2

The recoveries of zinc and lead in the total concentrates were, zinc, 20.89%; lead, 16.85%.

It is stipulated that these assays will be accepted as evidence without the production of the assayer.

939 By Mr. Williams: The specimen of granules produced by the witness is offered in evidence and marked "Complainants' Exhibit, Catterniole Granules, Chapman London Test."

250 Q. Have you also made a test in the same plant using oleic acid in the proportion of 1.8% on the ore, and the proportion of sulphuric acid given by Dr. Byrnes and used by you in your experiments 1 and 3 with cottonseed oil? If so, please describe the experiment.

A. I made this test using a very good oleic acid, purer than the ordinary red oil of commerce. The floats were very bulky and contained a very high proportion of gangue and very little enrichment of the crude ore took place. The procedure was altogether wasteful, and the result of no commercial value at all. If the agita-

tion froth process, when properly used, gave any such results as this, it would never have been adopted for practical use. The float obtained was oily in appearance and oily to the touch, but not as oily as in the other tests where I had used cottonseed oil and had used twice as much oil.

I used the same Standard plant with six agitators and six flotation boxes in operation, so as to come as near as possible to Dr. Byrnes' conditions. The time and temperature, and quantity of ore were the same as before, and the sulphuric acid was the same as in my cottonseed oil tests Nos. 1 and 3. The concentrates were
940 separately assayed and the tailings were assayed. The assay returns were as follows:

Experiment 4.

	Weight, total lbs.	Percentages.			% recovered.	
		Insol.	Zinc.	Lead.	Zinc.	Lead.
1st Conc.....	138	25.3	24.5	6.9	10.95	10.80
2nd Conc.....	284	30.0	22.3	6.2	20.55	20.15
3rd Conc.....	151	30.3	21.9	6.4	10.70	11.05
4th Conc.....	152	29.5	22.6	6.6	11.17	11.52
5th Conc.....	146	33.8	20.5	6.0	9.75	10.01
6th Conc.....	99	34.4	20.7	5.7	6.66	6.47
Tailings	710	—	13.1	3.7	30.22	30.00

The recoveries of the zinc and lead in the total concentrates were, zinc, 69.78%; lead, 70.40%.

I would say that these recoveries were in a concentrate of so low a grade that it would really not be considered a concentrate. If you were to take a ton of ore and shift it from one bin to another, you would have 100% of your mineral in the second bin.

251 Q. Did you analyze the gas in the float in any of these experiments? If so, please give the results of your analysis.

A. In one instance, as to my experiment No. 1, with cottonseed oil, I made careful gas analyses with an exact repetition of this run. It took quite some time to collect the gas in the float, but I got a fair specimen from each of the first four flotation boxes. The actual volume of air or gas in the floats was very much less than
941 in the normal agitation froth, but my tests showed that the proportion of CO_2 in this gas was less than we have found it in many gas analyses of the normal agitation froth and kept on getting less in the successive boxes. I made two series of tests to correct any possible error in one of them, and I give below the results obtained from each analysis and the average of the two analyses:

	1st analysis.	2nd analysis.	Average.
1st Box CO_2.....	2.8%	3.1%	3%
2nd Box CO_2.....	1.4%	1.8%	1.6%
3rd Box CO_2.....	1.1%	0.9%	1%
4th Box CO_2.....	0.6%	0.8%	0.7%

I used all the sampling glasses that I had for these analyses and had no further glasses for the fifth and sixth boxes.

252 Q. Did you make any tests with the proportions given in the Froment British patent?

A. Yes, I made two tests in the ordinary slide machine with 500 grams and 400 grams of Broken Hill tailings and other quantities in proportion.

First I determined how much oil would make a layer in an 80 cc. test tube of the oil which I used, which was Winter dark oil, the oil which was ordinarily used in the Elmore bulk oil flotation process at the time of the year, the present month of December, when I made the test. I found that 41 drops of Winter dark oil or 1.4 cc. or 12.6% of 10 grams of ore was the smallest amount to pro-
942 duce a layer. I noted the temperature of the room at the time, which was 65° Fahrenheit.

1st Experiment, Froment. I used 500 grams of Broken Hill tailings crushed to pass through a 60 mesh screen, and 50 grams of calcite similarly crushed; 1500 cc. of water; 150 cc. dilute sulphuric acid (containing 50 grams of mono-acid or concentrated sulphuric acid); and 70 cc. of Winter dark oil. I mixed the ore, calcite and water first to wet the ore and calcite. The acid and oil were then added and I put on the full current of the motor for two seconds. There was a violent evolution of gas, which caused a portion of the contents of the slide machine to be thrown out, and because of this loss, I abandoned the test. As a matter of fact, the float rose more than 7½ inches, which was the distance from the water level to the top of the machine, and overflowed.

2nd Experiment, Froment. Here I used only 400 grams of ore and reduced all other quantities in the same proportion. The quantities used were as follows:

400 grams Broken Hill tailings.
40 " calcite.
1200 cc. water.
120 cc. dilute sulphuric acid (40 grams acid).
56 cc. Winter dark oil.

I mixed the ore, water and limestone as before, then added the acid and oil and agitated for two seconds as before. The float rose to within two inches from the top of the slide machine, but sub-
943 sided to a float of about four or five inches in thickness after the violent evolution of the gas had ceased. After this violent evolution has ceased and the float had subsided, I took a sample of gas from the float and made two analyses of it as before. The first analysis showed that the gas in the float was 97.3% carbon dioxide; the second analysis gave 97% of carbon dioxide. The average of the two analyses was 97.15% carbon dioxide. My analysis of these gases determined the amount of carbon dioxide present. The rest of the gas, less than 3 per cent., was probably air. There was no odor of sulphuretted hydrogen in the gases. This was true as to all of the tests I have described in this deposition.

253 Q. Did you notice any odors during any of these tests?

A. Yes. During the cottonseed oil tests there was an unpleasant odor which had the effect of making me sick, and those working with me showed evidence of sickness and complained of sickness.

254 Q. Did you observe any effects on the apparatus of the use of cottonseed oil and oleic acid in the proportions used in these tests?

A. Parts of the plant were left in a dirty and greasy condition, which made it necessary to scrub all accessible parts with alkaline soft soap solution after the completion of the tests. After each series of tests we circulated a nearly boiling solution of weak alkaline soft soap through the entire plant, using in each lot 50,000
944 gallons of water and circulating it around for about twelve hours. All of these efforts did not clean the plant so that it could be used for normal agitation froth working. We then put several charges of ore pulp through the plant and finally restored it to condition for testing under normal conditions. It was nearly a fortnight before the plant was again in working order.

255 Q. Does normal agitation froth operation make a plant greasy as did the tests you have described?

A. No. The oil disappears. The dirt in the plant is never greasy.

256 Q. I call your attention to Q. 56 and Answer in the deposition of the defendant, James M. Hyde, Defendant's Record, pages 73, 74. What have you to say as to this?

A. Mr. Hyde appears not to be well informed as to the wide usefulness and application of the agitation froth process. It is applicable to the three copper sulphides appearing in ores, these three forms being chalcopyrite, chalcocite and copper glance. Mixed sulphide ores treated by it are usually marketable as concentrates, for example all Broken Hill concentrates are sold as a mixed concentrate of zinc and lead. The Swedish ore of the Saxbergets mine, when treated by the agitation froth process, produces a mixed concentrate consisting of zinc blende, galena (lead sulphide), and pyrrhotite (magnetic sulphide of iron). The pyrrhotite is separated by magnetic treatment and the zinc blende and galena
945 are separated on water concentration tables, as described by me in answer to 87 Q. (Complainants' Record, pages 196, 197).

As a matter of fact, the smelters penalize Broken Hill concentrates if they do not contain with the blende a fair proportion of lead.

257 Q. Do you know of any instance where cottonseed oil is used in the agitation froth process?

A. No. It costs more than oleic acid and is not as well suited as oleic acid. We have never considered it as a likely oil for this process.

Direct examination closed.

No cross-examination.

Deposition closed.

GEORGE. A. CHAPMAN.

By Mr. Williams: I now produce the Slide Machine which was used in Dr. Chandler's experiments for his testimony in the prima facie case, as well as in subsequent experiments at New York City, and which has been in my custody since its arrival in America, and offer it in evidence pursuant to agreement of counsel appearing at page 95 of Defendant's Record, and it is marked "Complainants' Exhibit, Slide Machine."

A stipulation of counsel is here recorded that as to "Complainants' Exhibit, Nutter Report, July 28, 1910," all portions of
946 the body of the report preceding the paragraph entitled "Recoveries" are withdrawn from evidence.

By Mr. Williams: I offer in evidence a stipulation as to extension of License and Option to Minerals Separation American Syndicate, Limited, and it is marked "Complainants' Exhibit, Stipulation."

Complainants here close their testimony.